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SUGGESTIONS FOR A NEW SYSTEM OF ROYALTY PAYMENT FOR TEAK FORESTS IN BURMA WORKED BY LESSEES UNDER PURCHASE CONTRACT.

[*Contributed.*]

1. Under the system at present in force, which is the only one ever employed for lessees of teak forests in Burma, either the lease of the forest is put up for tender, the sum tendered being the rate of royalty to be paid per ton on the outturn which arrives at duly appointed measuring stations: or the royalty payable under similar conditions is fixed by negotiation. The Forest Department girdles the trees, which the lessees undertake to fell and extract together with any dead and fallen timber which may be found on the ground. Under this method, although in most leases the rate of royalty varies to some extent with the quality of the timber, it is to the lessees' advantage to extract as much as possible of the high quality timber which yields a high return on the time and money spent on extraction, and to deal as little as possible with the poor quality timber, which yields a profit but not

a large profit. It is the business of the Forest Department to see that the lessees do not delay extraction and do not leave unextracted any timber which can be extracted at a profit. This is defined in the lease as "marketable" timber, and the word "marketable" gives rise to much discussion to put it mildly. The Forest Officer has frequently to bring to notice delay in felling, logging, dragging, and carting or floating; this delay is more or less immaterial to the lessees, provided that the capital laid out by them in plant and dragging power, and the supervising staff maintained by them, are kept working at full pressure: whereas delay in receipt of revenue by Government is of great importance. Again, loss of timber in transit by floating to measuring stations may be of considerable extent, and is often disregarded by lessees, from which it is inferred that they find it more profitable to employ their staff and dragging power on bringing forward more logs to the floating stream than in rescuing old logs. In this case the loss sustained by Government is obvious.

2. The object of the new system now suggested is to make the lessees interested equally with Government in avoiding delay in felling and dragging, or waste in logging, in launching logs to the extent and at the time economically most convenient, and in making adequate arrangements whereby all logs launched shall arrive at measuring stations with the least possible delay. The system may be outlined as follows:—

(1) Royalty to be fixed per girdled tree, one all-round rate for every tree, whether standing girdled at the time of tender, or to be girdled within a definite term of years: but trees girdled merely for sylvicultural reasons and held to be unmarketable should not be included for payment of royalty. There would be no charge for dead and fallen trees. This rate could be fixed by tender as at present. The unit of forest to be tendered for would be fixed as found convenient in every case. Separate rates might be tendered for different areas in one forest, and so on; the elasticity of the system would be one of its advantages. All

firms who have worked teak forests in Burma would have little difficulty in calculating the average outturn which has been obtained per tree girdled in forests where they have worked. In forests where they have not worked, adequate inspection by a competent man of experience should enable them to decide.

(2) As the trees stand three years after girdling before the lessees may fell them, the actual payment of the royalty would be distributed over a term of years, in some such method as the following :—

One-third on or before the date on which the trees become ripe for felling.

One-third one year later.

One-third one year later.

But this arrangement would be regulated by the known average facilities for extraction.

(3) In forests in which a firm has been working under the old system and is to change to the new, for several years after the expiry of the old lease timber felled under that lease, but not yet paid for, would be coming forward. In this case the old system of measuring for royalty payments would continue for these old logs.

(4) As an alternative to (3), a valuation might be struck for all logs known to be left unextracted at the end of the old lease, and these could be paid for by a lump sum without measurement, in two or three equal annual instalments.

(5) The control of the Forest Department would be maintained entirely in the forest at stump, and the department would not be concerned with the timber after it left the stump. This is as it should be, in view of the relative size of the staff maintained by the lessees and the Forest Department. Hammer marking would be done only by the contractors, with their property and classification marks.

3. Under the present system some ten Imperial officers of the Forest Department are employed every rains in measuring lessees' timber for royalty: under the system now proposed the services of these men could be used on works of improvement in the forest, and in checking lessees' fellings at stump.

4. The result of this system should be that the more marketable timber the lessees can obtain from the trees girdled and sold to them, and from the dead and fallen trees which they find, the greater will be their profit: and not a stick of marketable dead timber should remain in a compartment after a firm has worked it. Would one could say that of every compartment inspected now after the lessees have left it! Low quality timber which at present is left behind to rot or burn would be brought into the market and so lower the price of teak to the small consumer.

5. As far as can be foreseen, the only dispute that could arise would be as to whether a girdled tree is to be fairly classed as containing marketable timber, or not: to obviate dispute, it might be arranged that every girdled tree objected to by the lessees could be sold standing by Government to local traders, or be otherwise disposed of. The lessees would not care to have outsiders working in the same forests as themselves, and so would avoid making unreasonable objections.

6. The condition inserted in all existing leases, that no green ungirdled trees may on any account be felled, should be rigidly adhered to in the new leases: it is the mainstay of our check on lessees' work.

TEAK WORKING-PLANS IN BURMA.

BY H. W. A. WATSON, I.F.S.

I. PAST WORKING-PLANS.

When the preparation of working-plans for the teak forests of Burma was started, the existence of vast areas over which only one species was marketable limited the choice to the Selection system.

The general type of forest varying little and the system of working being fixed, a sameness in the plans was inevitable.

The Tharrawaddy Working-plans, compiled thirty years ago, have since served as models. Most of the variations from these standard types have tended towards idiosyncrasies that might with advantage have been suppressed, *e.g.*, more sketchy field work, compartment boundaries laid down on paper only, countings over a smaller percentage of the total area or to include only trees of the major species above a certain girth and a tendency to waste paper theorising on inadequate data.

(2) *Basis of proposals.*—Proposals were based on a division of the area into compartments, counting of the growing stock over a percentage of each compartment and the age of exploitability, as fixed by ring countings.

The felling rotation was usually fixed at thirty years, partly because this period represented roughly the time taken by a teak tree of 6 feet girth to attain to 7 feet in girth and partly because it was a convenient multiple of the age of exploitability, usually fixed at 150 or 180 years.

The stock calculated to exist on the whole area was reduced by arbitrary percentages, assumed to represent the trees unlikely to reach maturity, and the yield for the period was fixed at the number of trees that were calculated to reach the maturity girth plus half the surplus stock.

Areas to be girdled over were allotted for each subperiod, or fixed fraction of the felling rotation, on the principle of an approximately equal yield for each subperiod, occasionally combined with the allotment of roughly equal areas.

(3) *Criticisms.*—Calculations of stock based on countings over a fraction of the area can never be accurate; but in dealing with large areas, countings over the whole are rarely possible and it seems reasonable to suppose that when carried out in carefully selected sample plots over at least 25 per cent. the margin of error, while variable in the case of individual compartments, is not great in the aggregate.

The smaller the percentage enumerated, the greater will be the margin of error, and in this connection the later tendency to more sketchy field work and the substitution of linear valuations

for fixed sample areas has in my opinion greatly reduced the value of the later working-plans.

(4) One of the chief causes of inaccuracy in enumerations lies in the classification of sound and unsound trees. Defining unsound trees as non-yield trees, *i.e.*, not up to a certain specification, does not eliminate the personal element and in many instances trees cannot be classed standing.

Obviously the only safe method of classifying is that adopted in some recent plans of excluding as unsound only such trees as are obviously useless for timber.

(5) The allotment of compartments to be girdled over has generally been on the principle of putting those richest in mature stock in earlier subperiods and relegating the poorer compartments to the later subperiods. The relative accessibility and state of regeneration have not been considered.

There are, for instance, in the Shweli forests of the Ruby Mines Division and probably in other divisions, easily accessible areas which prior to British rule suffered from depletion of the younger stock for posts and timber, the older and larger trees being left as too unwieldy to move by native methods. The regeneration of teak in these compartments, fostered by heavy bamboo extraction, is excellent. Such compartments could with advantage be allotted to the earlier subperiods and heavy girdling be prescribed for them.

(6) The girdling prescriptions apparently contemplate an even distribution of the girdling incidence over the whole area, whereas it would often be more advantageous to girdle heavily in compartments where the regeneration is good, reducing the incidence elsewhere in proportion.

(7) Prescriptions for exploiting species other than teak have been vague and of little value.

(8) Prescriptions for work other than girdling and climber cutting have usually been wanting in clearness and frequently proved impracticable. The older plans slavishly copied their predecessors in prescribing fire-protection and the later plans, when criticism of fire-protection was no longer heresy, went to the

opposite extreme. Lack of labour, competent subordinates and in many cases lack of funds combined to keep improvement fellings in arrears. Another cause, however, contributed largely to delay this work and to confuse the subordinate staff, namely, the different opinions of individual Divisional Officers on the subject of what constitutes efficient improvement fellings. Some accepted that the elimination of useless species obviously injuring teak sufficed, whilst others wished the elimination of practically everything in the vicinity of teak groups. The former method allowed of the prescribed area being, almost, if not quite, worked up to. The latter caused arrears from the beginning. The effect of these divergent views on the subordinate brain, combined with frequent changes in the personnel of the Divisional Forest Officer, may be imagined.

2. Probable Trend of Future Working-Plans.

(9) Of late years there has been an increasing tendency to criticise the 'Selection' system and a growing desire for a more uniform method of working. The 'Uniform' system has been put forward as the system of the future, and while much may be said in its favour, its general introduction would mean an unjustifiable sacrifice of promising trees. Its suitability must, therefore, be limited for many years to come.

It must, moreover, always be borne in mind that we have to deal with forests containing, besides teak, many species, the possible economic value of which and their sylvicultural requirements, individually or in correlation with those of teak, are unknown to us, and until we know our forests more thoroughly any drastic change in the system of working would be rash.

Whilst not accepting the 'Uniform' system on the grounds that to effect its introduction involved unjustifiable sacrifice of immature trees, the consensus of opinion as expressed at a conference in 1910 was in favour of a more concentrated method of working. The conference was generally in favour of introducing a modification of the 'Uniform' system by combining the 'Selection' method with heavy repeated improvement fellings concentrated in one block during each felling period.

Assuming a period of 30 years and the area operated on by these improvement fellings to equal one-fifth of the whole area, the position in this block during the various stages of a 150-year rotation would be as follows :—

(i) At the end of 30 years on completion of improvement fellings and the first girdlings—

(*a*) Ordinary 'Selection' stock aged 30 to 150 years.

(*b*) New 'Uniform' crop aged 0 to 30 years.

(ii) At the end of 60 years after the second girdlings are completed—

(*a*) Ordinary 'Selection' stock aged 60 to 150 years.

(*b*) New 'Uniform' crop aged 30 to 60 years.

(*c*) New crop aged 0 to 30 years in the blanks left by the second girdlings.

(iii) At the end of 90 years after the third girdlings are completed—

(*a*) Ordinary 'Selection' stock aged 90 to 150 years.

(*b*) New 'Uniform' crop aged 60 to 90 years.

(*c*) New crop aged 30 to 60 years.

(*d*) New crop aged 0 to 30 years in blanks left by the third girdlings, and so on.

At the close of the rotation after the fifth girdlings have been completed—

(*a*) Nil.

(*b*) A 'Uniform' stock aged 120 to 150 years.

(*c*) New crop aged 90 to 120 years in blanks from second girdlings.

(*d*) New crop aged 60 to 90 years in blanks from third girdlings.

(*e*) New crop aged 30 to 60 years in blanks from fourth girdlings, and so on.

It is obvious that the heavier the first girdlings are, the more uniform will be the final crop and that in the absence after the first period of special aid, such as improvement fellings, bamboo extraction or gregarious flowering of the bamboo, the stocking outside that induced during the first period may be negligible.

Work in other blocks would be restricted to the removal of the surplus stock by ordinary selection methods until each in turn was dealt with on the lines laid down for the first block.

A system on these lines when properly developed will probably form the future system for the Burma teak forests.

(10) Some of the drawbacks to the system above indicated appear to be :—

(i) With our interest centered in teak we are apt to overlook the possible value of other species with a few exceptions. We forget that we know practically nothing of the bulk of the species that constitute our teak forests and propose recklessly cutting them out to make room for the major species.

(ii) While concentrating our attention on one block during each period, we propose reducing the stock in the four other blocks during varying periods without in any way compensating by helping the growth. Thus the fifth block will have passed through four girdling periods before its turn for improvement fellings falls due.

(iii) Rigid adherence to a girth limit when girdling will react adversely in cases where an immature tree dominates promising groups of young stuff.

3. SUGGESTIONS FOR FUTURE WORKING-PLANS.

(11) The following is a summary of my tenets regarding the sylviculture of teak :—

(i) Ingress of light induces profuse regeneration ; but only exceptionally can the young plants survive without help.

Observations convince me that teak regeneration receives an enormous impetus when bamboos flower gregariously. That there are not marked age-classes in the forest to correspond with past flowering cycles is due to the fact that in the absence of help, teak seedlings get exterminated over the greater part of the flowered area within five years after the flowering has taken place. Where the competition is with grass or a light growth, promising groups

survive on suitable soils. Creepers and evergreen undergrowth are the deadliest enemies. *Dendrocalamus Hamiltonii* flowered extensively throughout the Shweli forests some five years ago and for the most part failed to re-establish itself. Teak regeneration in the flowered areas is on the whole good; but varies considerably. In places there are patches of young teak, 15 feet high, resembling plantations. In other places the plants have been suppressed by the surrounding growth and in patches they have been exterminated by wild elephants. Detailed examination of one flowered area revealed smothered seedlings. In fact the patch examined reminded one of an abandoned plantation.

Similar smothered patches have been noted in an area where *Dendrocalamus strictus* flowered some ten years ago.

Where *Dendrocalamus membranaceus* flowered three years ago the impetus to regeneration is not marked. This I attribute partly to the fact that the flowering was straggling, sporadic rather than gregarious, and partly to the dense high clumps of the bamboo even when dead giving considerable shade. It is possible that past flowering of the Kyathaung has been of a similar nature.

Everywhere under 'tin' bamboo, large patches of advance growth are to be found.

Heavy elephant grazing does not markedly favour regeneration. Apparently the trampling consolidates the soil too much.

(ii) I am convinced therefore that the 'Uniform' method is eminently suited to teak. The general tendency of the species is to occur in groups of approximately equal age rather than singly and under certain conditions it forms approximately even-aged crops over large areas. Such conditions would be induced in evergreen forest when circumstances combined to temporarily oust the evergreen and in most cases probably are directly attributable to the intervention of man.

As an example may be instanced the Mong Hang forests in the Southern Shan States. Here we have a practically even-aged crop of teak and *pyingado* over 300 years old standing on the remains of ancient fortifications and on land that at one time was

thickly populated. Apparently as the population decreased and cultivation was abandoned teak got a start. Heavy cattle grazing, which noticeably favours teak, was probably responsible for its lead in the first instance.

There are, moreover, numerous instances throughout Burma of even-aged teak crops appearing on abandoned cultivation.

In the accessible parts of the Shweli forests we have even-aged groups of teak as a result of heavy and continued extraction of bamboos and other species. These have all been induced within the past 25 years, as it is only recently that such extraction has been really heavy.

Alluvial teak patches are frequently even-aged.

(iii) We must admit that the 'Selection' system uncombined with improvement fellings is unsuitable for forests in which only a fraction of the species constituting the crop is saleable. The drain on the species worked would eventually lead to their extermination.

Combined with light improvement fellings, *e.g.*, removal of a proportion of the unsaleable crop roughly equal to that of the saleable crop removed, we may maintain the balance but make no progress.

Combined with heavy improvement fellings, we increase the proportion of the major species by groups of roughly the same age and consciously or unconsciously in such areas are progressing from the 'Selection' towards some form of the 'Uniform' system.

(12) My suggestions are briefly as follows :—

Collection of data.—(i) Compartments should be chosen with easy natural boundaries. Whether or not these are demarcated by the working-plan officer or left to be demarcated when operations under the plan commence seems immaterial.

(ii) The estimate of stock should be by sample areas extending over at least 25 per cent. of the total area, the percentage of area counted being highest in the richer parts. I disagree entirely with the use of linear valuations for the collection of working-plan data. These

are useful and handy for brief surveys for reserve proposals or rough working schemes; but too rough and inaccurate for working-plans. Their location and future check is difficult, consequently their execution cannot be entrusted to subordinates. If carried out by the working-plan officer they waste time that would be more suitably spent on other work.

(iii) All trees in sample areas should be enumerated: the major species by foot classes; less important species, likely to prove of market value, in two classes (3′ to 7′ and over 7′ or 3′ to 8′ and over 8′ according to species) and unimportant species in one class (over 3′). No attempt need be made to enumerate seedlings; but notes should be kept and the relative abundance of those of the major species should be recorded on a stock map.

When the agency of enumeration is not a gazetted officer, the saving in time and money derived by restricting the enumerations to certain classes of certain species is not great and some knowledge of the relative density of the important species seems essential.

(iv) Only trees so decayed as not to yield a log should be classed as unsound. These may be enumerated in one class (over 3′) for each species or group of species enumerated.

(v) Two stock maps should be prepared, one to show the distribution of forests by types, the other to show the distribution of the regeneration of the principal species.

(vi) In the absence of adequate data, to the contrary, it may be assumed that it takes a teak tree 150 years to attain a girth of 7′ and the rate of growth for other species may be assumed to correspond.

Prescriptions.—(i) Thirty years represent roughly the time required for a teak tree of 6′ girth to attain to 7′ girth and should be accepted as the felling period. Each subperiod should be of five years' duration.

No allowance need be made for trees that will not survive for girdling. It may safely be assumed that the margin of error in calculating will suffice to cover such loss.

(ii) The calculated surplus should be spread over two or more periods.

(iii) The yield as calculated should be fixed and used as a check. Full allowance should, however, be made for an excess or deficit, resulting from sylvicultural considerations during girdling operations.

(iv) Equal areas should be allotted to each subperiod, combined, if possible, with the allotment of a roughly equal yield; but this last should be a very secondary consideration.

Compartments accessible to the extraction of species other than teak should be placed in the first subperiodic block. Where no such compartments exist, any that it is thought can be rendered accessible to such extraction during the first period should be so allotted. Failing either, compartments accessible to bamboo extraction should be placed in this block. With the hoped-for amalgamation of working-plans by forest divisions, there will always be compartments that are or can be rendered accessible in each division.

(v) The girth limit for sound teak in girdling operations should ordinarily be 8′ for moist and 7′ for dry forest.

In the accessible compartments, placed in the first subperiodic block, the girdling limit should be lowered to 7′ for moist and 6′ for dry forest and the girdling officer should have power to lower this limit in cases where sylvicultural considerations demand the removal of trees that are suppressing promising groups of smaller stuff.

Girdling in the first subperiodic block should be with the object of inducing a uniform crop. It should be heavy with a corresponding reduction of its incidence in other blocks.

(vi) The compartment in the first block should be scheduled with estimates for species other than teak and marking for trade fellings prescribed, the extraction to be either

contemporaneous with that of the teak girdlings or during the period while girdlings are maturing. If possible the marking should be done in conjunction with girdling or a year before so that it may be inspected at the time of girdling. This block should not be kept longer under exploitation than is absolutely necessary.

(vii) *Improvement fellings.*—The main consideration in connection with improvement fellings should be to as far as possible replace our present wasteful methods of hacking out and burning species that are not immediately saleable by inducing traders to extract these. Where such exploitation is hampered by restrictions, we should endeavour to remove these. It is economically better to mark trees and allow their extraction free of royalty than to spend money on felling and burning them. Of course in the easily worked places we can obtain the full royalty; but in hitherto unworked areas our money might frequently be better spent on an extraction path than on improvement fellings.

For purposes of improvement fellings, we may class the forests in three groups :—

(*a*) Areas that are accessible or that can with little difficulty be rendered accessible to extraction of all species.

(*b*) Areas accessible to bamboo extraction.

(*c*) Areas unlikely to be rendered accessible during the first period of the working-plan.

As much as possible of group (*a*) should go into the first sub-periodic block. When trade fellings have been completed improvement fellings will consist in eliminating the rejections unsound, *ficus*-bound and really useless species (unless haply we have managed to get this done by the extractor), the cutting back of damaged stems, climber-cutting and generally tidying up the area. Further improvement fellings to help the young growth will probably be necessary every five years till the close of the period,

Staff and labour difficulties will probably prevent our paying much attention to group (*b*) unless the forests fall into the first subperiodic block; but as bamboo cutting will not be called for, it may be possible to arrange for the felling of overmature and useless trees suppressing seedlings of the major species.

Improvement fellings in group (*c*) should be confined to the elimination of *ficus*-bound trees and obviously useless species, marked if possible in conjunction with girdling operations, together with the cutting of climbers on the major species. This work could conveniently follow girdling, its main object being to maintain the proportion of teak as compared with other species. The trees having been marked the work of cutting them out can be given on contract and even the most stupid subordinate will have no excuse to go wrong in its execution.

If improvement fellings on the lines indicated are prescribed, there seems no reason why the area of a working circle should not be gone over during each period.

Even confining improvement fellings proper to accessible areas we shall have enough to occupy our attention for one period and at the end of this time the radius of accessibility will probably have increased. The present methods of exploitation show little advance on those of prehistoric times. Any large increase in the value of timber will probably revolutionise them. In the meantime cutting out and wasting material that in thirty years' time may have a selling value is to be deprecated.

A schedule for improvement felling work on the lines indicated should be drawn up and rigidly adhered to with the one proviso, that in case of gregarious bamboo flowering other work be temporarily suspended, if necessary, to allow of full advantage being taken of the impetus to regeneration anticipated from the flowering. In such flowered areas all other species should be sacrificed to the welfare of the saleable species.

(viii) *Climber-cutting* should be carried out at the same time as improvement fellings and outside the first block should be restricted to climbers on the major species. We can never hope to eliminate climbers and

by confining cutting to those on the principal species we free them alone from a handicap and economise in time and money. The prescription that climbers should be cut in two places may safely be omitted, as the likelihood of this contingency is so rare as to border on the miraculous.

(ix) *Fire protection* should be considered broad-mindedly and apart from past traditions. I do *not* believe that fire-protection is anywhere necessary in the interests of teak though it undoubtedly favours certain other species, such as *pyingado* and *kanyin*. Temporary fire-protection may be advisable after heavy improvement fellings but even here I doubt its necessity. In these areas in moist forest a dense undergrowth soon springs up which prevents heavy fires. Dry forests do not lend themselves to heavy improvement fellings. Early systematic burning will probably prove an efficient substitute for fire-protection, which in the absence of strong reasons to the contrary should be generally discontinued as financially unjustifiable.

(x) *Sowing and planting.*—Every effort should be made to utilise the services of *taungya* cutting tribes to plant up old *taungya* areas that are deficient in teak and evergreen areas where teak will grow. *Taungya* plantations may also be necessary in connection with the formation of forest villages with a view to retaining the labour supply. In any circumstances their formation is financially sound and the position of areas that are suitable for planting operations should be indicated on a map appended to the working-plan, accompanied by estimates of areas available in each compartment.

(xi) *Boundaries.*—A table for annual boundary repairs on a five-year rotation would be a useful accompaniment to the working-plan.

(xii) *Communications.*—These should be dealt with from the point of view of inspection paths, extraction roads and clearing obstructions from streams and a map should be prepared to illustrate conditions and proposals. Where the extraction of the major species is in the hands of lessees, the proposals for extraction paths will largely refer to the first block; but suggestions for work in other blocks will prove useful.

(xiii) *Buildings.*—Existing buildings should be entered on the map illustrating communications together with suggestions for the future.

(xiv) Finally detailed proposals for staffing the areas should be put forward.

(13) To sum up.—During the first period endeavour to promote a more uniform growth in areas where extraction of all species is or can be rendered possible. If this area is insufficient for the staff and funds available, add as much of the area accessible to bamboo extraction only as can be managed. When considering the question of allotting areas, the forests of Burma should be considered as a whole and not by divisions or other units. Even whole divisions should be classed as inaccessible if it is thought that funds can be utilised to greater advantage elsewhere. It is unlikely that funds and staff during the first period will admit of our tackling more than the accessible areas.

Confine work in other areas to girdling under the 'Selection' system with light improvement fellings on the rough general principle of removing overmature, unsound and *ficus*-attacked trees of all species in a proportion to counteract the removal of the principal species during girdling, with the provisos that should abnormal conditions, such as gregarious flowering of bamboo, arise, energy should be concentrated on taking advantage of same and plantations may be formed when conditions admit of their formation.

(14) In conclusion, I would suggest that the compiler of a working plan receive more consideration. He frequently has to carry out this work as a sideshow to other duties. Naturally the working-plan suffers.

TEAK WOOD.

BY S. F. HOPWOOD, I.F.S.

'The consumption of teak has increased considerably during 'the last two decades. Besides its extensive employment in ship-'building in England and the manufacture of railway carriages in 'India, it is now used in increasing quantities in Europe for building 'purposes. The recent rapid growth of the European fleets has 'caused an enormously increased use of teak in spite of the marked 'tendency to employ as little wood as possible in the construction 'of warships. About 1,000 tons, or approximately half a million 'board feet, of the best grades of teak are used in the construction 'of a modern man-of-war. In order to replace the ships which 'have thus far been sunk or otherwise destroyed in the European 'war, hundreds of millions of feet will be required. This increased 'consumption of teak which is bound to follow the close of the 'present war, cannot be met by Burma and Siam. Formerly Burma 'alone supplied all the teak used by the English Admiralty, because 'it was considered better than that from Siam, but the demand for 'teak from both sources is likely to be very great, not only in Europe, 'but also in America, and prices are apt to rule very high."

The above is a cutting from the *Scientific American* dated 3rd April 1915. It has remained for America to point out to the Forest Department in Burma one of the obvious effects of the war. It is probably true that the increased consumption of teak owing to the building of steamships and warships which is bound to follow the close of the present war, especially if the German submarine successes continue, cannot be met by Burma but there is not the slightest doubt that the yield from Burma might be enormously increased without violating any sylvicultural principles. The teak forests of Burma are worked either under working-plans or under girdling schemes. It would be well to consider in what way the yield of teak could be increased both from forests under working-plans and girdling schemes.

1. In some divisions girdlings are much in arrears; these should be brought up to date in the coming working season. Last year

"no teak trees were girdled in the Taungnyo Reserve, Zigôn Division, owing to the large number of trees awaiting extraction"—(Report on the Forest Administration of Burma for the year 1913-14). Here is a case in which double girdlings can be done this year. (We have three years in which to make arrangements for the extraction of the trees.)

2. The prescriptions of the working-plan once they have been finally sanctioned by Local Government should not, as is usually the case, be considered unalterable. Schlich repeatedly draws attention to the advantages of not adopting a rigid and unalterable policy in Forestry. "Though the financial aspect should never be lost sight of, there are many cases where a departure from the financial rotation is fully justified. This occurs where short rotations interfere with the preservation of the yield capacity of locality, where considerations for the production of a certain class of produce or the dictates of political economy are of paramount importance"—(Schlich, Vol. III, p. 293). And again, "Temporary high prices can be fully utilised by cutting more than the normal yield for a time"—(Schlich, Vol. III, p. 115). Unlike all other trees teak cannot be felled and extracted at a moment's notice. Each teak tree has to be killed and stand dead for three years before it can be extracted so that it behoves the Forest Department in Burma to start putting its house in order at once for there is not the slightest doubt that if this is not a case "where considerations for the production of a certain class of produce or the dictates of political economy are of paramount importance" there never was and never will be such a case. From the above-quoted extracts it is evident that Schlich would not hesitate to exceed the normal yield and even to encroach on forest capital if he thought it necessary. Much can be achieved without taking such an extreme step as this. Most working-plans prescribe girdling for one felling rotation of 24, 30 or 40 years and as, when these working-plans were made, the forests had never been worked before to their full possibility, there was always a surplus of class I, *i.e.*, mature trees over 7′ 6″ in girth, on the ground. With regard to these mature trees the argument in the typical Burma Working-plan with a

40-year felling rotation runs somewhat as follows:—"In a normal forest, however, the annual yield is equal to the annual increment. In this case the annual yield is $\frac{40,000}{40}$ = 1,000 trees; and in order that the forest capital be not encroached on there must always be on the ground $\frac{40}{2} \times 1,000 = 20,000$ *trees. There now remains* on the ground therefore a surplus of 30,000 — 20 000 = 10,000 trees. The removal of all this surplus during the first period would not be advisable. It is proposed therefore to spread the removal of the surplus stock over two periods, the number removed annually being $\frac{10,000}{80}$ = 125 trees. By spreading the removal of the mature trees over two periods in this way a great drop in the yield after the first period will be avoided." These are two fallacies to be found in nearly every Burma Working-plan, namely, that there will be a large drop in the yield after the first period and that the removal of the surplus stock in the first period would be a bad thing. As regards the forest it is most improbable that there will be any large drop in the yield. Opening up remote forests and improved working will do much to increase the yield. In any case this "drop in the yield" would not be a drop in the real yield but would be due to the removal of a surplus arising from the fact that we are working in virgin primæval forests. If there is a probability of a drop in the yield the way to avoid it is not to leave large numbers of overmature trees on the ground for perhaps 60 to 80 years. Again if we do not remove this surplus stock of mature trees in the first period it is obvious that we shall not have so many of them to remove during the second period; they are all 7′ 6″ in girth and more now, they are overmature and they should be extracted, for a large percentage will not survive 40 to 80 years more. This method of spreading the removal of the surplus over two periods ingeniously seeks to avoid the much-dreaded drop in the yield by reducing the yield altogether. Better far that a large percentage of our mature trees should never be extracted than that there should be an apparent drop in the yield! The above indicates only one way of increasing the immediate yield.

3. Lessees should be asked whether they would be able to extract more trees if more trees were girdled for them. If so, girdlings might be doubled or trebled, *e.g.*, a working-plan with a felling rotation of 30 years which has been in force 20 years should be revised and double girdlings done for the next five years, the first period being altered to one of 25 instead of 30 years. This is quite a legitimate procedure. "At one time it was the practice to prepare working-plans of high forests for long periods of time even as much as a whole rotation. Such a procedure is to be strongly deprecated, because the conditions which govern the working of a forest change from time to time. Although the general lines of action must be determined for some time ahead so as to secure continuity of action, the detailed prescriptions for the management should be laid down only for a short period, say, 10 or perhaps 20 years. This is especially desirable where a working-plan is prepared for the first time, and where the data upon which it is based are as yet incomplete. It is desirable, in such cases, to revise the existing arrangements in the light of the experience gained during the actual working of the forest for a limited period"—(Schlich, Vol. III, p. 245). The length of these periods or felling rotations in Burma is purely arbitrary; in most working-plans there is some very unconvincing argument which tries to make out that the length of these periods is a multiple of the rotation. If 40 years is chosen it is probably said that there will be four periods of 40 years, if 30 years is chosen, that there will be five or six periods, and so on. In many cases a revision as indicated above would not only be of benefit to the forest sylviculturally but advantage could be taken of the revision to combine some of the all too numerous Burma working-plans into one plan with common schemes for the whole area, provision being also made for the extraction of timbers other than teak. (This has been done in India. What is wanted is a working-plan like that for the reserved forests of the Nimar District, Central Provinces.) The working-plans in each division therefore should be studied; those in which the first felling rotation could be shortened with advantage should be revised at once.

4. Another method of increasing the outturn in the immediate future would be to girdle in the next few years only in compartments (or coupes in the case of girdling schemes) from which extraction is easy. From many compartments or coupes timber takes several years to reach Rangoon, while from others it reaches Rangoon in the same year that it is launched. Prescriptions of the working-plans or felling schemes should be studied and where difficult areas are laid down to be girdled over this year easy areas should be substituted. Another advantage of girdling over areas from which extraction is easy is that buffaloes can be often used, enabling firms whose elephant-power is limited to employ their elephants elsewhere.

5. At present owing to the scarcity of steamships and consequent high rates of freight, stocks of teak in Rangoon are large and the prices in Europe have not risen much. There may be something in the rumours of an attempt to be made to corner teak in the near future.

Teak would lend itself to this more readily than many other things which have been cornered successfully, such as wheat, owing to the fact that at least three years would have to elapse before an increased supply of teak could be thrown on the market. A successful corner in teak would be a very bad thing for Burma and the best way to frustrate such a corner would be to have large stocks of girdled trees standing on the ground. If double girdlings were done this year, even supposing it should not be found necessary to extract all the trees after three years, no harm would be done by allowing the trees to stand girdled an extra year. With the large number of school-trained Rangers and Deputy Rangers now to be found in each division there should be no difficulty in carrying out double girdlings this year.

6. The last but not the least advantage of this increased working of teak would be an increase of several lacs of rupees in the Provincial revenues—an increase which would be very grateful in the years of lean budgets which will follow the war.

AN ADMINISTRATIVE ASPECT OF THE COPPICE-WITH-STANDARD WORKING IN THE BHANDARA FOREST DIVISION, C. P., WITH SPECIAL REFERENCE TO THE EFFECTS OF DRIP AND SHADE FROM THE SURROUNDING TREES ON THE COPPICING CAPACITY OF SOME OF THE MORE IMPORTANT SPECIES.

BY M. NARASINGA RAO, P.F.S.

The Government forests of Bhandara Division are situated in the catchment area of the Weinganga and are 533 square miles in extent. The greater portion of the forests is on almost flat country. The underlying rock varies in different parts but consists chiefly of gneisses, schists, quartzites, hard sandstones and granite. With regard to the composition of the crop the mixed type of forest is the most common throughout the division. The principal species in their order of frequency are—

Terminalia tomentosa, *Cleistanthus collinus*, *Bassia latifolia*, *Buchanania latifolia*, *Lagerstrœmia parviflora*, *Anogeissus latifolia*, *Diospyros Melanoxylon*, *Chloroxylon Swietenia*, and *Pterocarpus Marsupium*. *Boswellia serrata* is commonly found on ridges and on shallow and poor soil. Teak is found in patches here and there.

2. Out of the 533 square miles of forests 468 square miles are worked on the coppice-with-standard system and over the balance of 65 square miles, which form the hilly portions and where the demand is restricted, improvement fellings are being carried out on a rotation of 15 years.

3. The 468 square miles of forests which are worked on the coppice-with-standard system are divided into 32 Felling Series each with 30 coupes. At present 5 out of these 33 Felling Series are not being worked partly due to inaccessibility and to want of demand. In the rest of the 27 Felling Series the demand for small timber—straight poles—and firewood is quite good considering that the district contains large tracts of zamindari and malguzari forests. Nearly 75 per cent. of the firewood and 50 per cent. of the poles are consumed in the district itself and the balance is railed

on to Nagpur and the markets situated in the rich and prosperous Berar Division. Owing to this good demand for timber and firewood all the 27 annual coppice coupes are readily saleable.

4. The advantages of selling coupes standing need hardly be dilated upon here. The establishment is saved all the bother of departmental working with its numerous loopholes and temptations for dishonesty. As nearly half the revenue of the Division is derived by coupe sales the department cannot be too careful in studying the convenience of the coupe purchasers, in order to safeguard them from loss of money. Generally the coupes are sold in the month of July and the purchasers begin working the coupes, at any rate felling the timber poles, by the end of August. The cutting of trees fit for fuel commences by the beginning of November. It is obvious that from a sylvicultural point of view the rainy season is the least suited for carrying on fellings but an important administrative question affecting revenue has to be *considered.*

5. Though a clause has been inserted in the agreement bond binding the purchasers of coupes to carry on fellings in one continuous operation, *i.e.*, felling all trees, whether fit for timber or firewood, from one end of the coupe to the other, still in practice the purchasers were allowed by successive Divisional Officers to cut the timber poles in the rainy months, and to fell the trees fit for fuel only in the cold weather. This is now an established practice in the division. The reason for this concession is that there is a strong prejudice amongst the people of this district against small timber that is not cut during the rains. The people appreciate the effects of water seasoning and they cannot shake off the idea that poles cut in any season except the rains are liable *to attack by insects. During his inspection tour in 1912-13*, Mr. Haines, the then Conservator, took strong exception to this practice. He argued that the straight poles which the purchasers picked up during the rains were very thinly distributed all over the area, and if they were cut in the rains, *i.e.*, before the other trees were felled the stools of the former would either not throw out coppice shoots or even if they did, the growth of these would

be immensely retarded owing to the shade of the surrounding trees and also the drip during the rains. It was then ordered that the practice of cutting poles in advance of cutting firewood yielding trees should at once be put a stop to and the purchasers of standing coupes made to carry on fellings in one operation. This order was given effect to during the sales of the standing coupes in June 1913. The result was that the purchasers accepted the condition very unwillingly and the prices of coupes fell by Rs. 15,000. During the ensuing rains the condition was strictly enforced. Many of the purchasers of coupes did not cut and collect even half the number of straight timber poles. They felled everything in one operation and stacked it as fuel. The reason for the inability of the coupe purchasers to cut and collect timber poles under the changed system of work as outlined above is as follows:—An acre of our coppice coupes yields on an average 50 poles. Assuming that the average size of a coupe to be 300 acres the total number of poles to be extracted by the purchaser is 15,000. August and September are the months when field labour is in great demand. Hence it is with great difficulty that every one of our 27 coppice coupe purchasers can muster a sufficient number of coolies to work their coupes. Assuming that a cooly cuts and collects 25 poles a day, a total of 600 coolies is required to work 15,000 poles. This gives 15 coolies a day if we count 20 working days in a month. More than this it is not ordinarily possible to find. Therefore before the enforcement of the condition of working the area in one operation the purchasers were just able to cut and collect all the poles in the months of August and September. In 1913 when they were forced to cut both timber and firewood together they were unable to operate more than one or two acres a day with the limited number of coolies at their disposal. Hence, their inability to collect all the available stuff. With the advent of cold weather more labour is available, but the timber cut in that season the people of the district do not care for.

6. It was after this experience of 1913 that the importance of the question raised by Mr. Haines was fully realised. The coupe purchasers lost heavily in that year's operation and so far as could

be judged they were not in a mood to bid for our coupes in the sales of 1914 unless the restrictive clause regarding the advance cutting of poles was eliminated from the agreement bond. Thus the administrative was opposed to the sylvicultural question. The Chief Conservator of Forests toured in the Bhandara Division in the months of December 1913 and January 1914. On this question being placed before him he inspected several worked coupes in which the poles were cut during rains in advance of other trees yielding fuel only and he did not notice any bad effects of drip and shade on the coppice shoots. The growth and quality of the shoots in all these coupes looked to be uniform. In consideration of the anticipated loss of a large amount of revenue and of the fear of disturbing a well established system of coupe sales it was again ordered that the purchasers of coupes should be allowed to cut the poles in advance. It was also decided that the felling of other trees should be commenced immediately the poles had been all cut. The result of this change was that in the coupe sales of 1914 the revenue became normal. The matter did not rest here. In February last while touring in this Division, the then Conservator, Mr. Beechey, noticed that some of the stools which we definitely knew were those of poles cut during the immediately preceding rains did not send up any coppice shoots at all. Since then the matter has been receiving special attention. In April last I saw that several stools of poles cut in the rains did not either throw out coppice shoots or the shoots were very weak. In one of the coupes where this feature was conspicuous 50 stools of different species have been marked down with a view to ascertain whether they will throw out shoots at all. The species which seem to be particularly sensitive to the bad effects of drip and shade are:—*Terminalia tomentosa*, *Cleistanthus collinus*, *Bassia latifolia*, *Lagerstræmia parviflora* and *Diospyros Melanoxylon*. These are our very important species.

7. From what has been written above it will be seen that the point at issue is whether it is worth our while to compel the purchasers of coupes to work the areas in one operation knowing that this restriction would result in a loss of Rs. 15,000 or Rs. 20,000

per annum. Even presuming that a large percentage of the stools of those poles cut in advance do not send out coppice shoots, does the benefit of having coppice shoots from these stools compensate for the large loss of revenue? It is to be remembered that 50 poles, on an average, is the yield per acre as stated in para. 5 above. Supposing that these 50 stools do not throw out any coppice shoots, will not at least 500 other trees per acre be sufficient to stock our forests with an adequate number of coppice shoots? Again in addition to the thousands of coppice shoots per acre we get some fresh seedling growth at every rotation to compensate us for the loss of coppice shoots from the stools of those 50 trees cut in advance. Apart from this aspect of the question the actual effect of shade and drip on the stools of poles cut in the rains presents a problem of considerable sylvicultural interest.

PTEROCARPUS SANTALINUS (RED SANDERS).

SOME OBSERVATIONS REGARDING REPRODUCTION, GERMINATION AND GROWTH OF SEEDLINGS.

BY SAIYID ABDUL QADIR, P.F.S.

Red Sanders, curiously enough, is so limited in its distribution in nature, and yet so much in demand for every kind of conceivable work, from ornamental to agricultural, from construction of houses to construction of carts, besides preparation of pretty toys and vessels, that it forms one of our most valuable timber trees of India. It is, therefore, important that its peculiarities of growth and development, its requirements and the best means of tending, should be carefully studied and recorded. With this object in view, I have here endeavoured to put down a few observations, however desultory they may be, made during my demarcation of Red Sanders areas in the East Forest Division of the Cuddapah District, the home of this species.

REPRODUCTION.

1. *Season of flowering and fruiting.*—Red Sanders is perhaps one of the earliest trees to shed its leaves, so much so that in dry exposed localities and southern slopes of hills, the leaf-fall is

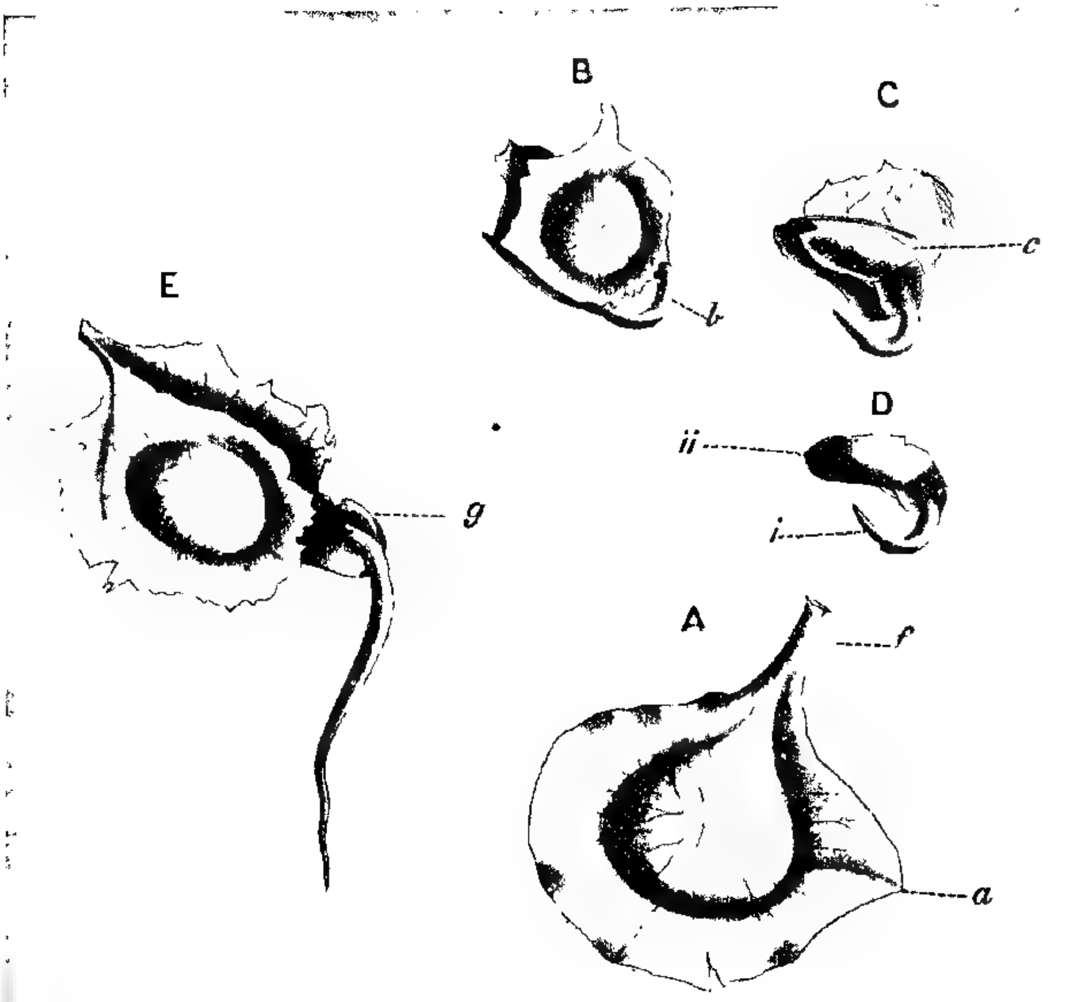
nearly half accomplished by about the end of January; and by the end of February almost the whole blocks of Red Sanders forests in these localities present a desolate appearance. In moister localities the fall begins, say, about the commencement of February, and is complete by about the middle of March. As it is almost the first tree to shed its leaves, it is also, perhaps, the first tree to throw out a new flush of leaves. Early in April, before any other of its associates has even attempted to show remote signs of reclothing itself, Red Sanders is seen putting out tender, green leaves. It is, therefore, only for about a month in moister localities to about a month and a half in dry localities that it remains leafless.

Flowers appear soon after the new leaves in April, and continue to the middle of May. The fruit is then seen on the tree, but does not ripen till the next February or March, when the tree has again shed its leaves showing bunches of dark brown pods on most of its branches.

These pods remain on the tree until the south-west winds commence to blow hard about the month of May, when they are disseminated, being helped in their dispersal by the narrow wing with which the pods are provided.

It is thus to be noted that the seed falls during the second half of the fire-season by which time a number of fires have probably already occurred. The pod is provided with a tough fibrous coat which naturally protects the seed inside to a certain extent against external calamities. All the same, an intense fire is sure to reduce it to ashes. Many of the seeds, however, escape a light ground-fire, the outer protective coat only being scorched or the wind mercifully deposits them on a spot over which the fire had already passed; while some cling to the tree till late in the season and are sometimes seen mixed with the new green pods of the current season. At all events, the seeds that survive these calamities are ready on the ground when the first showers of the monsoon fall, to perform their part in the regeneration of their own kind.

2. *Periodicity of flowering and fruiting.*—The subject of periodicity of flowering and fruiting requires careful observation



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A. *Pod of Red Sanders. (a) stylar insertion. (f) stalk of the pod.*

B. *Pod showing 1st stage of germination. (b) hypocotyledonary loop.*

C. *Pod with one half of pericarp removed. (c) seed germinating.*

D. *Seed germinating separated (i) radicle (ii) seed coat.*

E. *Pod showing hypocotyledonary loop nearly straightened, radicle distinctly developed, and cotyledons half come out. (g).*

(Natural size).

extending over a long series of years. In the absence of collected data, I resorted to enquiry which pointed to the fact that, as in the case of some of our valuable timber trees, Red Sanders also flowers and fruits prolifically in certain years. Though this information should be taken for what it is worth, it is worth while recording here, with the hope that those that have anything to do with Red Sanders areas in future years will observe and note from time to time their observations as to :-

(i) whether data regarding periodicity are proved by actual observations; and if so,

(ii) whether flowering and fruiting occur at definite intervals or not; and if it does, at what intervals; and

(iii) whether any causes natural or otherwise tend to alter the periodicity.

GERMINATION.

To observe the actual germination from seed, a few experiments were carried out both in the Kodur Red Sanders plantation and at Cuddapah. Though they have not been very elaborate, the results obtained are, none the less, of some value and I have, therefore, ventured to record them here briefly.

Experiment No. 1 at Kodur.

A small plot was prepared and a basketful of seeds were sown on 17th September 1914 by thrusting the pods perpendicularly in the soil with the stalk-half of the pods exposed above the surface of the bed. The bed was watered both morning and evening daily, except when there was rain. The first signs of germination were observed on 25th September 1914, *i.e.*, about the eighth day after sowing, when a few pods were found to have been pushed up a bit. On the 27th, *i.e.*, exactly on the tenth day as many as 50 seedlings were seen with their cotyledons spread out. On the 2nd October nearly 50 per cent. of the seeds sown had completely sent out their cotyledons.

The bed was very closely sown and some seeds were still germinating on 21st October.

Experiment No. 2 at Kodur.

Three small beds were prepared and 264 seeds were sown in the same way as above on the 11th October in rows of 11 each, the seeds being put down about two inches apart and watered twice a day. On the 21st, only 4 seedlings came out, and on the 30th, 56 seedlings, or over 1/5th of the seeds sown, completely germinated. On 7th November when this bed was again examined there were 73 seedlings, *i.e.*, about 28 per cent. of the seeds sown.

The germination was rather slow here, compared to that in experiment No. 1. I believe it is due to the watcher's failure to water regularly twice, as in the first case.

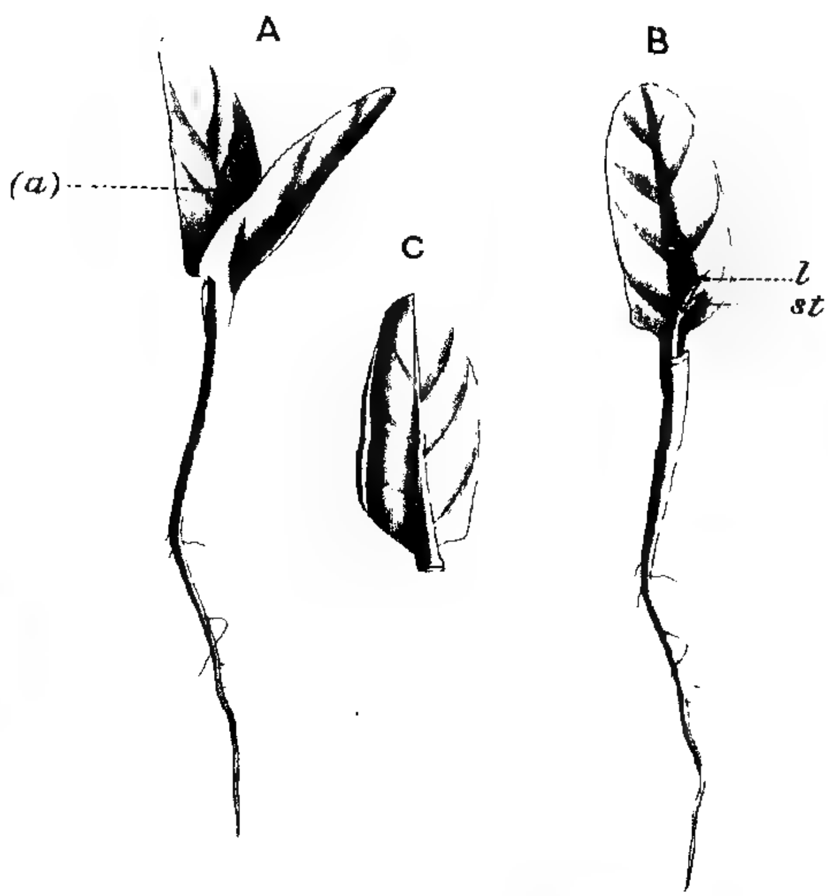
Experiment No. 3 at Kodur.

In a fresh bed 65 seeds were sown on the 26th October entirely buried perpendicularly, with stalk-half exposed and watered as above. On the 19th November, when the bed was examined, only 10 seeds were found to have germinated. Subsequently, it was reported that 14 seedlings were only existing in this bed.

This experiment seems to indicate that by fully burying the seeds in the soil the germination is delayed; but without further verification, this statement cannot conclusively be asserted.

Watt in his "Dictionary of Economic Products of India" states on the authority of Mr. Yarde's paper read at the Forest Conference meeting held in 1875 that "they (the seeds) germinate, if previously soaked for a night in cold water, in twenty to twenty-five days, if not so treated, in thirty to thirty-five." I wonder whether Mr. Yarde in his experiments sowed the seeds completely buried as in my experiment above.

A series of similar experiments were tried at Cuddapah in my bungalow compound to compare the results, adding one more series of soaking seeds in cold water from 24 to 36 hours previous to sowing. The whole set of experiments entirely failed, except in the case of a solitary seedling that came up on the tenth day out of the bed in which seeds were put down after 24 hours' soaking. In these experiments seeds used were very much over one year old



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A. *Seedling showing cotyledons spreading out (a) plumule.*

B. *The same seedling with one cotyledon removed. (st) stipule (l) leaf.*

C. *Cotyledon.*

(Natural size).

and the failure must probably be attributed to this, otherwsie all possible care was taken by me personally.

In yet another experiment carried out at Cuddapah, I obtained in October some fresh pods from those that were still on the trees, and sowed them in that very month, in other words, quite six months prior to their natural dissemination. All of them looked healthy, but as I expected not a single seed germinated. Obviously these were not ripe then to germinate.

Some attempts were made at noting the results of transplanting without baskets or balls of earth. When the seedlings were about two months old, they were pricked out and transferred to other beds and regularly watered. Most of the seedlings thus transplanted appear to have taken root and survived for a couple of months. With the progress of dry weather, however, they all gradually disappeared. Transplanting was done in November and December, that is, about the middle and end of the North-East Monsoon rains which are followed by a long dry weather. Obviously this is not a very favourable season to undertake pricking out. The operation should be tried just after the first showers of the South-West Monsoon about the beginning of July. The transplants then will have the advantage of the few showers of that period, followed by a comparatively cool season, and then by the North-East Monsoon. It has also been fairly conclusively proved from general observations on the growth of seedlings in the natural forest, that in the very beginning of their life, protection from heat is essential to their growth. Our transplants, on the other hand, were put out in the open. This is probably another reason that contributed to the disappearance of transplants. I would suggest for future experiments that seedlings six months old at least might be selected, and after pricking out, protection by means of, say, branches of shrubs be given.

No attempts were made to transplant with bamboo baskets or bamboo tubes, as Mr. Yarde, who was the first to undertake artificial tending of Red Sanders, entirely resorted to this method and the beautiful Kodur plantation is the standing monument of the successful results obtained thereby. Mr. Yarde gives July as the

best month for putting the seedlings out after transferring them to bamboo baskets.

THE PROCESS OF GERMINATION.

Before describing the actual process of germination it will be desirable to give a brief description of what has so far been spoken of as "seed." "Seed" of Red Sanders in common parlance is what is technically known as its "pod." This pod is generally one-seeded, though clearly 2-ovuled in the ovary. The centre of the pod is more turgid and extremely hard. The insertion of the style in the pod is turned towards the basal corner. (See Plate 1.)

As described in the above experiments, the pods were mostly sown perpendicularly half-buried in the soil, with the stalk-half exposed above the surface of the bed. The earliest signs of germination were generally observed on the 8th or 9th day, when the pods appeared to have been displaced slightly and pushed up a bit. This is due to the fact that the radicle first develops and pushes its way out with the hypocotyledonary portion in the form of a loop, through the stylar insertion in the pod, creating a slit thereby along the suture near that insertion. The loop then unbends and the radicle enters the soil and develops into a tap-root while at the same time the hypocotyledonary portion tends to become erect, and in this attempt frees the cotyledons, which by this time have half come out from the pericarp, through the slit already made. Thus it is the force which the loop exerts as soon as it projects out of the pod in order to unbend itself, that displaces the pods in the seed bed and pushes them up. Now, the cotyledons having freed themselves spread out. The plumule begins its development and puts out the first tiny leaf with two tiniest stipules on its sides. The tap-root which is now distinct rapidly grows in length and develops minute rootlets. (See Plates 1, 2, and 3.)

It should be noted that though eventually the leaf is trifoliately compound, the first leaves are simple. (See Plate 3.) I have noted that the leaves of the seedling up to as many as four show no tendency to change to their compound nature. It would be interesting to detect when the compound nature of the leaves begins.

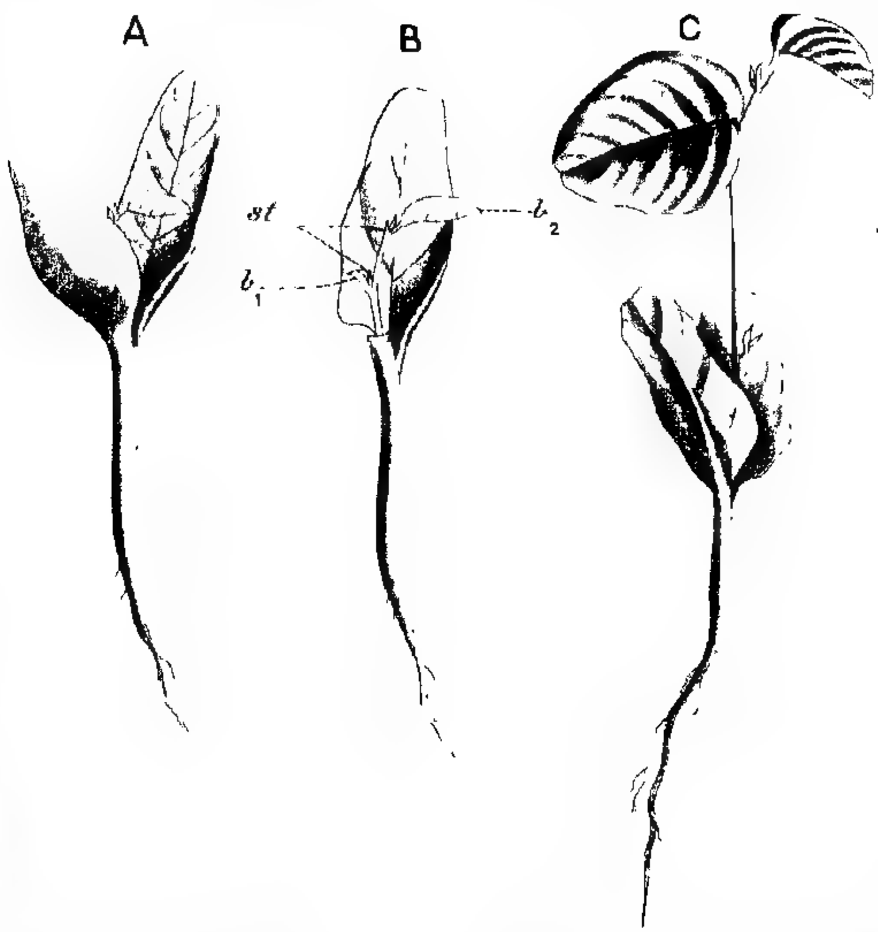

Photo-engraved & printed at the Photo.-Mechl. & Litho. Dept., Thomason College, Roorkee.

A. *Seedling showing 2nd leaf.*
B. *Same seedling with one cotyledon removed (b_1) 1st leaf (b_2) 2nd leaf (st) stipules.*
C. *Seedling showing 2 simple leaves.*

(Natural size).

SUMMARY AND CONCLUSIONS.

(1) Red Sanders seed appears to lose its vitality, if preserved for more than a year after it is mature. (This point, however, needs further investigation as it is based on only one experiment.)

(2) If sown perpendicularly with the stalk half exposed, it generally germinates in 10 to 15 days after sowing; and germination may continue for over a month. The germination, therefore, is fairly quick and easy.

(3) By entirely burying the seeds in the soil, the germination takes about 24 to 30 days. (This inference is not conclusively proved and needs further investigation.)

(4) A large percentage of seeds fail to germinate.

(5) For transplanting November and December are not well suited, as the dry months that follow tend to kill the transplants. (This has also to be confirmed by further experiments).

SANDALWOOD.—ITS PARASITIC HABIT.

BY K. G. M.

Mr. C. C. Wilson in the August number of *Indian Forester* says as follows :—

"Its parasitic habit of growth excited considerable interest and this was even called in question by some authorities, though afterwards verified beyond dispute."

I do not doubt that Sandalwood is of a parastic habit ; but that it cannot grow without a host is still open to proof as is borne out by the following fact :—

In 1912, January, I collected a handful of seeds. These were sown in baskets of 4 diameter and 8′ deep. About 50 per cent. of the seeds germinated. When about 4′ high they were planted out in June with the baskets the bottoms of which were removed. Owing to excessive rain or some other cause some of the plants died. Thirty-two plants came up successfully. *Lantana* had been previously planted in the plots where it was proposed to put out the Sandalwood plants, but none of the *Lantana* came up The 32 Sandal-

wood plants flowered and seeded last year in December. Except short grass the 32 plants had nothing in the way of hosts. Teak plants were planted 6 feet from the Sandalwood plants: these latter may have sent out their roots to the teak plants. I have not verified this. Even granting that this may have been so, the 32 plants had no hosts on which to depend till their roots had reached the root-system of the teak plants, if this was so, in any case this *could not have occurred in less than a year*, unless the root-system of the grass at the base of the Sandalwood was sufficient to serve as a host, which seems very improbable.

Secondly, one of the plants, out of the 32 plants, was blown over by the wind last June. It was cut back and the small branches cut to short lengths and stuck in the ground. Five of the branches have taken root and are doing well. This seems to show clearly that Sandalwood will grow from cuttings as well as from seed.

My argument is that if good growth is possible for about a year with no apparent host, is any host necessary later on and if so when?

OIL OF TURPENTINE AS A HÆMOSTATIC.

A severe case of bleeding after an operation on the elbow resisted all treatment until the wound was packed with gauze soaked in oil of turpentine. The hæmorrhage, which previously had been severe and long continued, at once ceased. The successful use of the oil has been proved on many other occasions. Its chief sphere of usefulness as a hæmostatic is in cases of secondary hæmorrhage. It is of no use until the area to be treated has been thoroughly freed from blood clot and débris; and it is especially valuable in those cases in which no bleeding point can be caught, but in which the hæmorrhage is nevertheless alarming. The oil is an antiseptic, and gauze saturated with it keeps wonderfully sweet, while by its action on the living tissues it gives rise to a slimy pus which greatly facilitates the removal of the gauze in the course of forty-eight hours. The only local inconvenience to which it may give rise is some blistering of the skin, which need not occur if care is exercised in its application. Its use is not limited to limbs; for bleeding from a tooth socket the author knows of nothing that is its equal. Doubt is expressed as to the value of oil of turpentine as a hæmostatic when taken by the mouth.—G. Grey Turner, M.S. (Durh.), F.R.C.S., in the *Lancet*, July 31st, 1915, 226.—[*Pharmaceutical Journal.*]

THE LARGEST DICOTYLEDONOUS SEED

In his recent botanical exploration of Panama, Mr. Henry Pittier discovered a tree known to the natives as *alcornoque*, and to which he has given the name of *Dimorphandra megistosperma.* The species' name has reference to the enormous seeds borne by the tree, exceeding in size those of any other known dicotyledonous plant. Mr. Pittier collected some of these seeds over 7 inches long by 4·7 inches broad, growing in pods nearly 10 inches long. The tree is allied to the *mora* of Guiana, and grows to heights exceeding 100 feet. Its wood is said to be better than any other for structures kept permanently under sea-water.—[*The Scientific American.*]

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REPRODUCTION OF TEAK BY ROOT-SUCKERS.

BY EDWARD MARSDEN, I.F.S.

In his study of Teak in the Wynaad published in Vol. XL of the *Indian Forester*, Mr. G. F. Foulkes stated (p. 192): "Where free seedling reproduction is absent the tree reproduces itself from *coppice shoots and more chiefly from root-suckers. This is the* case at the present time not only in the Wynaad but throughout the Teak areas of the Madras Presidency. This method of reproduction of the tree (*i.e.*, by root-suckers) also accounts for its growth in little patches which have so often been noticed and alluded to by writers on the subject, but the significance of which does not appear to have been clearly grasped" (p. 258). "This regeneration is found in little patches or groups, not because, as some people have supposed, Teak is a semi-gregarious tree, but because these patches are brought about by the growth of root-suckers" (p. 259). "The Teak does not grow in patches because it particularly wishes to do so, but because the soil conditions are such as to preclude its equal desire to reproduce itself from seed. There is no necessity to "open out" the forest to secure the growth of root-suckers, as

Fig. 1.

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REPRODUCTION OF TEAK BY ROOT-SUCKERS.

they will come up in any event and wherever there is an existing root-system, as soon as the soil conditions allow them to do so." "The above remarks may not be acceptable to the reader, but if they are true, the latent vitality resides not in the seed of Teak but in its root-system."

These statements evoked a certain amount of comment from Forest Officers in other provinces where Teak is found, and an enquiry was started to ascertain whether the reproduction of Teak by root-suckers is a characteristic of the species throughout its area of distribution.

The following replies were received :—

Madras ...	Southern Circle ...	No instances found.
	North Malabar ...	One specimen found with five root-suckers (Fig I); and other specimens collected showing 2 or 3 suckers each.
		"One typical patch of young plants was taken up ; it measured 6′ by 5′; a trench was dug around it and the earth from between the plants then worked out. It was found that this patch contained three separate groups, the first consisting of five and the second and third of two shoots each; each of these groups came away separately and the roots from which they sprang could not be connected with any existing stump or tree ; they appeared to belong to some tree long since dead and decayed. In this group there were no seedling plants."—(Mr. A. M. C. Littlewood.)
		The soil was hard and dry, with loose stones and boulders; sheet rock in places. Covered with grass, and grazed annually but apparently not liable to damage by fire. "In other localities where the soil is moist and loose, suckers are not to be found."—(Mr. A. B. Myers.)
Bombay ...	Panch Mahals ...	Mr. D. R. S. Bourke found two small root-suckers with some difficulty after a lengthy search. He considers this form of reproduction "of rare and not general occurrence" in Panch Mahals.
Central Provinces...	Amraoti ...	No root-suckers found.
	Jubbulpore-Narsinghpur.	Ditto.
	Akola ...	Ditto.
	Hoshangabad ..	No root-suckers from old Teak trees found. But seedlings die back year after year from frost, drought, etc., and in such cases new shoots arise sometimes from the root-stock, sometimes from the base of the stem.—(Mr. Nazir Abbas.

Fig. 2.

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REPRODUCTION OF TEAK BY ROOT-SUCKERS.

	Saugor ...	Mr. Shrikrishna found Teak root-suckers (Fig. II) on rich well-drained black cotton soil, free from stones, and covered with humus, bearing a dense growth of trees, closed to grazing and now fire-protected. The injuries on the roots are ascribed to damage by fire before the area was protected.
United Provinces ...	Gorakhpur ...	No root-suckers found.
Burma ...	Lower Chindwin.. Minbu ..	Root-suckers were found. (Fig. III.) Ranger Maung To Aung of Lower Chindwin reports that "in each case the parent tree was growing on a paddy field 'Kazin' (bund or small embankment) and the suckers had grown out to the paddy field. The horizontal root from which the suckers arose was only about 9 inches below the surface. The parent tree was 5 to 6 feet in girth and the sucker was in one case about 4 feet distant and in the other 2 feet distant. Each was single." The Divisional Officer, Lower Chindwin, succeeded in finding another specimen when three root-suckers had arisen after the parent stem had been felled.

It is generally understood that for some species reproduction by root-suckers is the normal method of propagation, but for the majority of timber trees the development of root-suckers is a sign of illness or of unsuitability to locality, even when there is no other symptom. On bad soil or when the roots are injured by the passage of animals or otherwise, and particularly if the tree is felled, a stimulus is provided for the formation of root-suckers.

In the *Indian Forester*, Vol. XXX, page 161, Mr. A. W. Lushington notes the prolific reproduction by root-suckers of *Xylia dolabriformis* in Cochin in areas which had been burnt and where the roots were at all exposed.

And in Coimbatore a method of reproducing *Ougeinia dalbergioides* by root-suckers appears to have been introduced based upon exposing the upper surface of small roots.

Several species were noticed reproducing themselves by root-suckers in a cutting on the roadside where the roots were exposed. Teak is noted by Mr. Lushington as producing very few root-suckers under these conditions.

"There almost always (but not always apparently) seems to be a better chance of suckers springing up when a portion of the

upper surface of the lateral root (or underground branch) is exposed in places; as mentioned above, they seem to come up more prolifically from trees which have been felled."—(Mr. A. W. Lushington.)

In the same volume of the *Indian Forester*, page 450, Mr. G. M. Ryan notes that reproduction by root-suckers is common "where the ground is bouldery and at the same time porous beneath," but has not been observed in mixed forest with a relatively dense leaf-canopy where the soil is comparatively cool. "In the case of Teak the reproduction is stimulated only when the aerial portion has been cut down and when the trees stand on a plot exposed to full illumination of the sun's rays." "Complete exposure of the surrounding soil caused by the previous removal of all jungle wood species" stimulates reproduction by root-suckers.

In some cases heat appears to provide the stimulus, "due to the exposure of the root-system caused by cracks in the black soil," and again "the heat caused by the burning of the grass, it was found, stimulated the subterranean buds into activity just as it does in the case of the rhizomes and roots of some strong grasses and weeds."

An excellent photograph by Ranger Bhudbhudi is appended to Mr. Ryan's article, showing three Teak root-suckers rising from a complicated system of roots, the remains of a Teak tree whose dead stump appears in the centre. This photograph is similar to that of the five Teak root-suckers found by Mr. Littlewood in North Malabar (Fig. I) and shows how deceptive the resemblance to seedlings may be.

In these examples of Teak root-suckers, certain characteristics appear common to all:—

(*i*) The "root-suckers" are close to each other or to the parent stem (usually not so far that their point of attachment to the "root" could not have been reached by a buttress or a lateral extension of the stem).

(*ii*) The "roots" are damaged or eroded on the upper side.

(*iii*) The "roots" are near the surface.

(*iv*) The parent stem is generally decayed.

Before discussing the real nature of these Teak "root-suckers," however, it is advisable to draw attention to the following extracts from an interesting paper on the subject by Mr. E. Fernandez which was read at the Forest Conference held at Simla in 1876:—

> "In 1866, the year after the road from the Sonbadra to Bori was made, Captain Doveton observed a few Teak shoots on the road, which shoots he traced down to cuts and bruises made by cart-wheels in roots." "But," he writes,

"I could not say now if they were from roots of trees outside the road, or from roots of trees that were in the road and were cut out. The distance from the parent stem it is, therefore, impossible to give."

To ascertain whether these shoots were true suckers, or merely one of the many instances of ordinary shoots that spring up more or less in contact with the parent stool, the following experiments were tried :—

(i) I had the soil dug up round eight trees, which I then cut down below the level of the ground. In two out of the eight cases, just enough of the stem was left to keep the principal roots connected. In the rest the stem was quite cut out, separating these roots entirely from each other; along with the stem a less or greater portion of the root was, of course, removed. The earth with chips of wood was then thrown back. All the trees were over 80 years old, three of them hollow and decaying.

(ii) I wounded the exposed portions of the principal roots of upwards of 100 trees. In some cases a chip of bark only was taken off with a sharp axe, in others a portion of wood was also removed; some of the wounds were made with a blunt instrument, others with a stone, and so on. A considerable number of the wounds were more or less covered over with fine earth, or ashes or cow-dung.

(iii) Similar wounds were made in the underground portions of many principal roots, and lightly covered over with soil,

(iv) And lastly, I dug up carefully the extremities of some principal roots and covered most of them up lightly with soil, leaving some in their natural position, others slightly bent upwards, to favour the production of suckers, if any were likely to come up.

Of the eight trees exploited underground, five threw up shoots the following rains, among these the two in which a portion of the stem was left. These latter, it must be noticed, produced the greatest number of shoots. In the three other successful instances the shoots sprang up, from, or close to, the section of the roots; the three cases of failure were those in which the largest portions of the principal roots were cut away with the stem. Making allowance for differences of soil, the strongest shoots were produced by those which had lost the least portion of their principal roots. Experiments II, III and IV were complete failures; moreover, an inspection of over 5,000 stools coppiced did not show a single shoot that had not sprung up in contact with the stools. Besides this, on many occasions when I have met with young Teak plants that from their position to trees near them looked like suckers, I have had them carefully dug round and have invariably found their roots entirely distinct from those of the suspected parent trees.

From the above facts the obvious conclusion is that Teak is not disposed to throw up suckers. Had it possessed this tendency, in the first place a few out of the many cases examined would have presented shoots growing directly from a root; in the second place, Experiments II, III and IV, which put the roots in the most favourable conditions possible for throwing up suckers, would not have been all failures; and in the third place, reproduction, number and vigour of the shoots in Experiment I would not have been in inverse proportion to the length of the principal roots removed in the exploitation and the cutting out of the stem.

The specimens of Teak "root-suckers" which have been recently collected indicate that these shoots have arisen in the immediate vicinity of the parent stem, which is in agreement with

Fig. 3.

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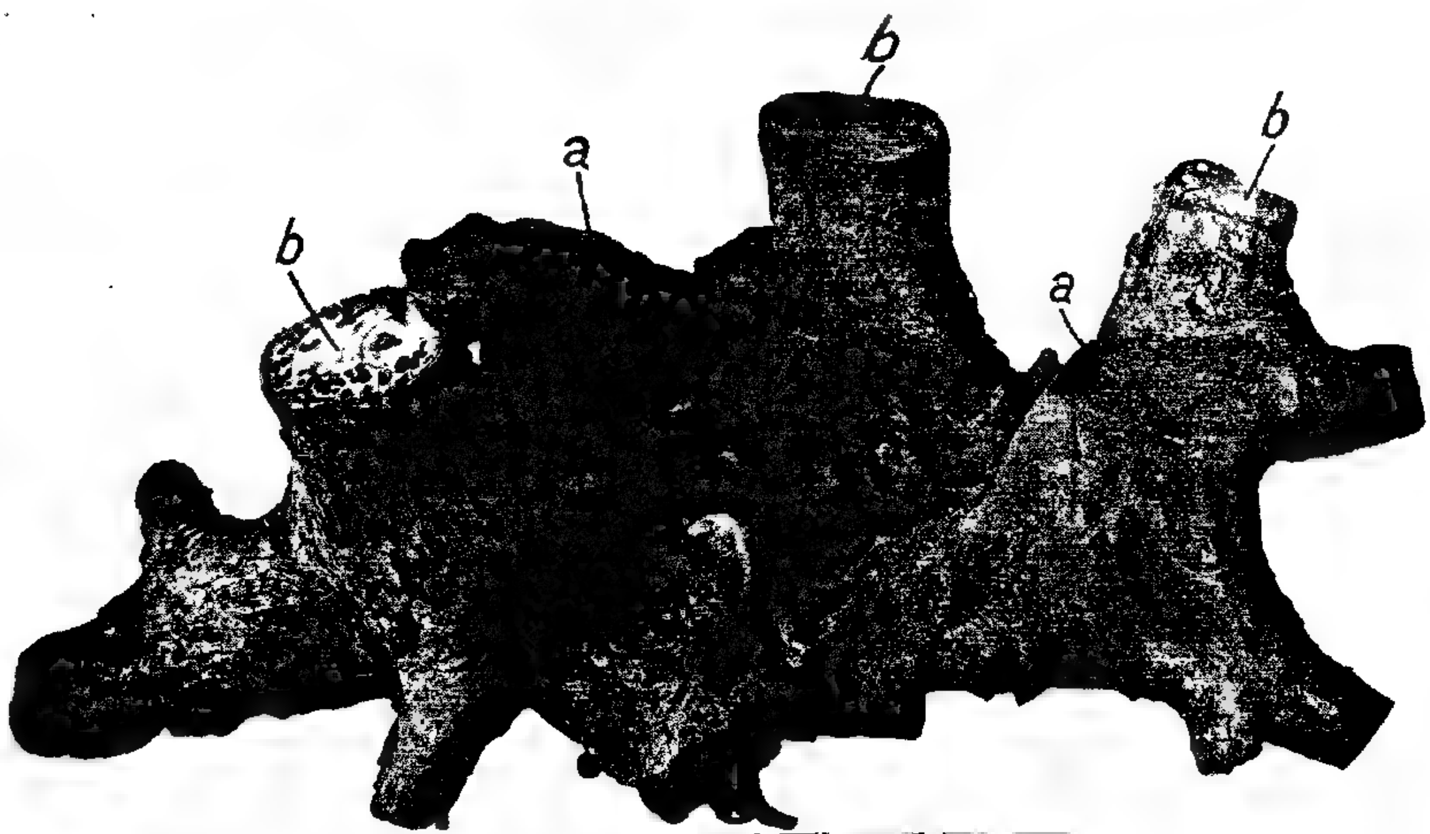
REPRODUCTION OF TEAK BY ROOT-SUCKERS.

Fig. 4.



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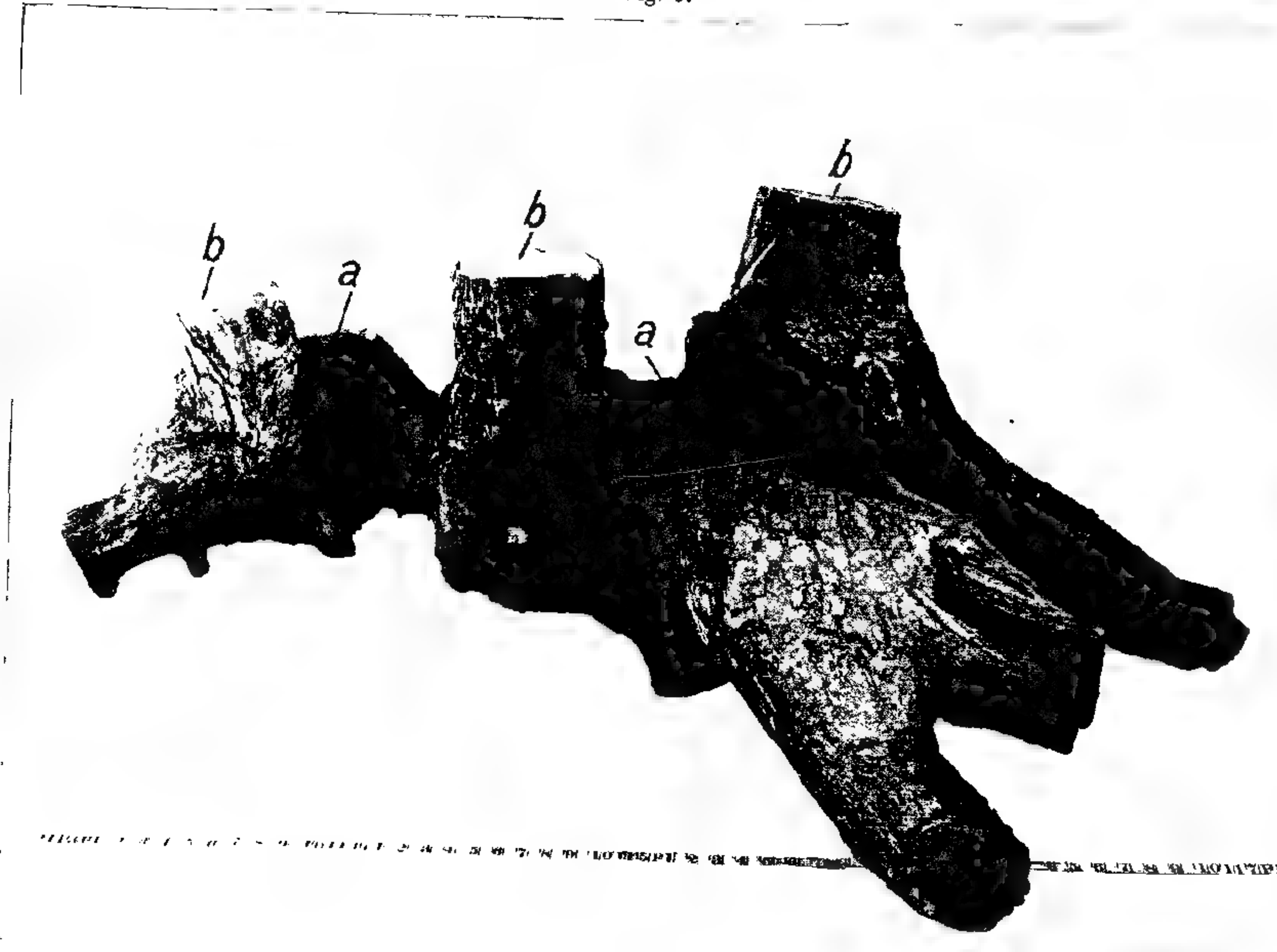
REPRODUCTION OF TEAK BY ROOT-SUCKERS.

Fig. 5.



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REPRODUCTION OF TEAK BY ROOT-SUCKERS.

the observations of Mr. Fernandez. Before proceeding further, it is advisable to draw attention to the following facts :—

(1) The root-system of Teak is frequently very superficial and in such cases the base of the stems becomes very irregular in outline, owing to the production of more or less well-developed buttresses which are the aerial continuations of the vigorous lateral roots.

(2) When a buttressed stem is felled at or near the ground surface, these buttresses are cut through and then form irregular projections of the stool; the lower the cut, the greater will be the extent of the buttresses included in the stool.

(3) The best stool shoots, in the case of Teak, frequently arise at the ends of these buttresses, *i.e.*, at the heads of the vigorous lateral roots. In this way, therefore, a shoot which really springs from the head of a root may be situated actually on the circumference of the stool. Provided the stool remains intact, however, foresters would undoubtedly term such shoots "stool-shoots" rather than "root-suckers."

(4) In the case of old trees, however, only those portions of the stool in the immediate neighbourhood of the healthy stool-shoots remain alive, while the rest slowly decays. In this way a group of healthy shoots may be produced which is united by the decaying mass of the old stool. Continued decay, however, may in time completely isolate the living shoots by separating them from the parent stools. Figs. IV and V show an interesting example of a tree which has been twice coppiced. In the centre is still seen the decaying remains of the original stool; *a, a* are the first stool-shoots and on these shoots being felled, *b, b* were produced. Note the position of one of the latter at the head of a lateral root far removed from the centre of the original stool. This stool-shoot on being isolated by the further decay of the stool would probably then be called a root-sucker,

Fig. VI shows a smaller less vigorous stool. On the left side the decayed remains of the old stool, showing annual rings, is visible; on its right side are two shoots which, but for the presence of the old stump and its proximity, would probably be called typical root-suckers.

From the evidence at present available, therefore, it is believed that many of the so-called "root-suckers" of Teak are really "stool-shoots," as ordinarily understood by foresters, and that true root-suckers are comparatively rare, these being usually confined to a few shoots which originate near the head of the roots close to the parent stem. Reproduction by root-suckers, therefore, as ordinarily understood in forestry, which means that the felling of the tree results in the production of numerous shoots springing from the roots at a more or less considerable distance from the parent stem, can scarcely be said to exist in the case of Teak.

In conclusion it is interesting to note the following:—

In 1911 Mr. Biscoe, the Conservator of Forests, Indore, wrote to Mr. Hole, the Forest Botanist:—

"May I ask if it is not thoroughly recognised that it is by root-shoots (or suckers) that much of the regeneration of our Teak forests in these parts is accomplished. We here have no doubt on the subject but a certain Forest Officer recently expressed his doubt on the matter." To this Mr. Hole replied: "Regarding root-shoots of Teak. The shoots seen by me are, as a rule, more correctly described as stool-shoots than as root shoots. They are frequently well provided with independent roots and are often more or less isolated on outlying portions of an irregularly shaped spreading stool, at the head of the old roots, but I have seen no clear case of a shoot springing from a root at a considerable distance away from the parent stool." As a result of further investigation, Mr. Biscoe wrote in 1912: "I have obtained a *very few* specimens of what seem to be undoubtedly *root-shoots*, but we have been certainly mistaking *stool-shoots* for *root-shoots.* I have quite changed my mind as to the extent of their prevalence in our Teak forests."

I am indebted to Mr. Hole for calling my attention to the paper of Mr. Fernandez and also for the loan of the specimens shown in Figs. IV, V and VI.

Fig 6.

Photo-engraved & printed at the Photo.-Mech. & Litho. Dept., Thomason College, Roorkee.

REPRODUCTION OF TEAK BY ROOT-SUCKERS.

TEAK REPRODUCTION AS A RESULT OF CLEAR FELLING.

BY R. S. HOLE, I.F.S., FOREST BOTANIST.

1. One of the subjects entered in the programme of work for the Forest Botanist for the period 1910—13 was the study of the factors favouring the rapid germination of the seed and development of the seedlings of teak. Owing to the advisability of concentrating attention, at first, chiefly on the Sal tree, only a few preliminary experiments dealing with teak have as yet been possible and some of the results of these are given below.

2. In the dry teak forests of Central India it is of primary importance to secure the early germination of the seed at the commencement of the rains and vigorous development of the seedling throughout the rains. Seedlings which have thus made full use of their first growing season and have a well-developed root and shoot at the end of the first rains are most likely to persist successfully and to escape damage from drought in the dry season.

3. In order to test the effect of shade and of an admixture of dead teak leaves in the soil on the germination of teak, an experiment was initiated in the Dehra Dun Experimental Garden in 1913. Two adjacent seed-beds were used, one-half of both beds being shaded with an iron shade and one-half being left uncovered. The type of shade used is shown in Fig. 1 (Plate 10) and is so constructed that all the rain-water falling on the shade is delivered on the shaded beds below. The shaded area, after the seed-beds had been dug and prepared as usual, was divided into three equal parts (each being 5′ long and 6′ wide) which were treated as follows :—

(1) a layer of dead teak leaves, 12 leaves thick, was laid on the surface, the seed was sown in this and the whole then lightly covered with soil ;

(2) treated as in (1) but with a layer 6 leaves thick instead of 12 leaves ;

(3) the seed was sown as usual direct in the soil, no dead leaves being added.

The unshaded area was also divided into three similar parts which were treated in exactly the same way as the above.

TEAK REPRODUCTION AS A RESULT OF CLEAR FELLING.

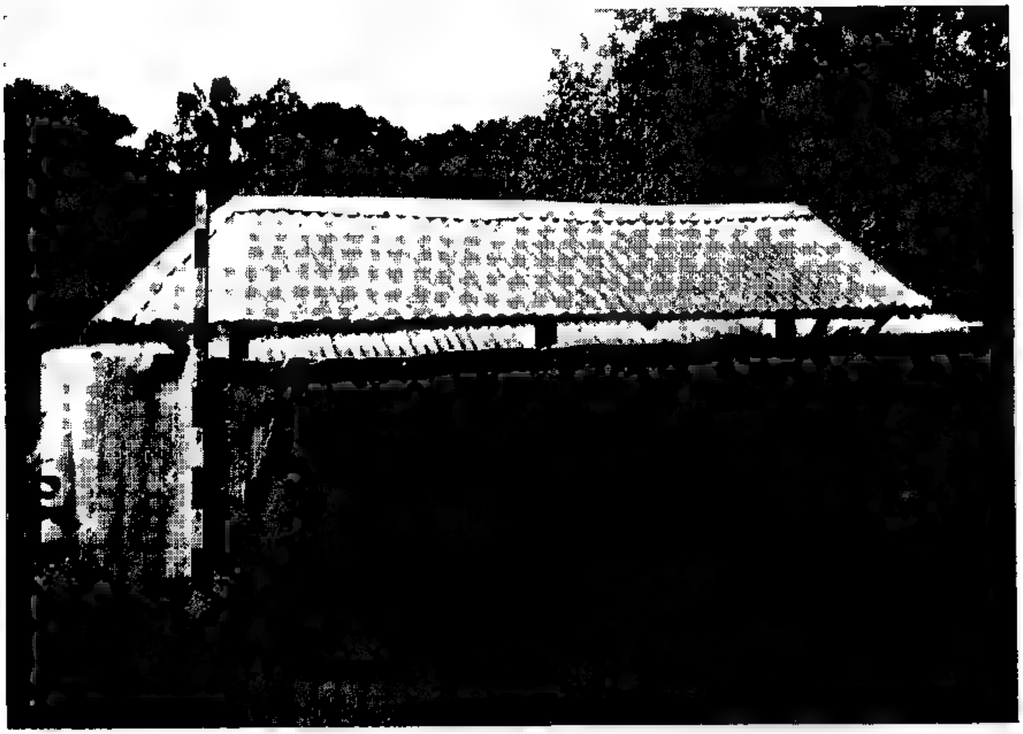

Fig. 1.

Fig. 2.

4. On July 2nd, 1913, 600 teak seeds, received from Burma, were sown in the shaded beds (200 in each of the three areas enumerated above) and 600 were similarly sown in the adjacent open area on the same day.

During the rains of 1913 the following results were recorded :—

	SHADED PLOTS.				OPEN PLOTS.			
	With 12 leaves.	With 6 leaves.	No leaves	Average.	With 12 leaves.	With 6 leaves.	No leaves.	Average.
Date of sowing	July 2nd, 1913.							
Number of seeds sown	200	200	200	...	200	200	200	...
Percentage of plants which germinated, calculated on the number of seeds sown.	1	1	1	1	20	18	12	17

In all, seven seeds germinated under the shade of which one was actually outside the edge of the shade and, therefore, really in the open. In the open area, on the other hand, 100 seeds germinated and the germination, therefore, was 1 per cent. and 17 per cent. respectively, in the shade and in the open. The above statement also indicates that the admixture of dead leaves apparently was not the dominant factor influencing the germination in the shade.

In the open, however, the admixture of dead leaves materially improved both the percentage of germination and also the vigour of the young plants.

In June, 1915, *i.e.*, after two years, there were no living plants actually in the shaded area, but the single plant produced by the seed outside the edge of the shade was alive and vigorous, as were also the plants in the open area. On June 28th, 1915, the iron shade was removed and Fig. 2 (Plate 10) shows the appearance of the beds on July 19th, 1915. The framework of the shade is seen on the right of the photograph and the only noticeable plant in the shaded

area is the single vigorous specimen seen behind the shade. This arose from the seed which was outside the edge of the shade. On the left of the photograph are shown the vigorous 2-year-old plants in the unshaded area. On November 16th, 1915, 27 of these plants in the open (which were then about 2 years and 4 months old) showed an average height of 8′ 3″ (5′ to 14′). Fig. 2 (Plate 10) also shows that the effect of an admixture of dead leaves in the soil was still visible in July 1915, the tallest plants, nearest the shade, being situated in the area which received a layer of dead leaves, 12 leaves thick, whereas the shortest plants on the left, the furthest from the shade, are situated in the area which received no dead leaves.

5. It has been already noted above that in June, 1915, *i.e.*, after two years, there were no living plants actually in the shaded area. On June 28th, 1915, the iron shade was removed and the surface soil in the shaded area lightly dug over.

The removal of the shade was immediately followed by the germination of a number of seeds, and on July 18th, 1915, 76 healthy seedlings were counted in the shaded area. On July 24th, 1915, there were 79 seedlings in the area. The cotyledons were seen on these plants and it was, therefore, clearly a case of delayed germination and not of regrowth from plants which had previously germinated and then died back. In this case, therefore, and the removal of the shade had caused the germination of 79 teak seeds which had remained dormant in the soil for a period of two years. On November 17th, 1915, 21 of these seedlings which had germinated in the shaded areas (which had been treated with dead teak leaves in 1913) and which were then about four months old showed an average height of 15 *ins.* (6¾ to 24 *ins.*). It is instructive to compare this development with that of the following teak seedlings also grown in the Dehra Experimental Garden in 1915 from Burmese seed :—

(1) 42 plants grown in the open and weeded but with no dead teak leaves ; average height on November 17th, 1915=5·5 *ins.* (2½—14½ *ins.*). Seed sown June 29th, 1915.

(2) 26 plants grown in the open and weeded but with more or less considerable side shade on all sides. No dead teak leaves added to the soil; average height on November 19th, 1915 = 6·6 *ins.* ($4\frac{1}{2}$—$10\frac{1}{8}$ *ins.*). Seed sown June 29th, 1915.

In both these cases, the average plant did not germinate until July 28th, 1915, whereas, in the case of the dormant seed in the shaded areas mentioned above, the average plant germinated on July 8th, *i.e.*, practically three weeks earlier. The superior development of the latter must no doubt be ascribed in part to this early germination, and this emphasises the importance of early sowing and early germination. In part, the good development was possibly due to the favourable condition of the soil caused by the disintegration of the teak leaves added in 1913.

6. The experiment described in para. 3 above was repeated in another part of the Dehra Garden in 1915. The iron shade used was similar but slightly larger and the soil was treated with dead teak leaves, etc., exactly as in the 1913 experiment. The chief difference in this case consisted in the fact that the experimental area was surrounded by more or less considerable side-shade.

The results are shown below :—

	Shaded plots.				Open plots.				Remarks.
	With 12 leaves.	With 6 leaves	No leaves.	Average	With 12 leaves.	With 6 leaves	No leaves.	Average.	
Date of sowing	June 29th, 1915								
Number of seeds sown.	200	200	200	...	200	200	200	...	All the plants which germinated in the shade had died by September 27th, 1915.
Percentage of plants which germinated, calculated on the number of seeds sown.	2	2	3	2	30	39	54	41	

A comparison of these results with those given in para. 3 show that :—

(1) Both in 1913 and 1915, germination was much better in the open than in the shade.

(2) Both in 1913 and 1915, the admixture of dead leaves was not the dominant factor influencing the germination in the shade.

(3) In 1913, the admixture of dead leaves materially improved the percentage of germination and the vigour of the seedlings in the open.

In 1915, the admixture of dead leaves gave the worst results in the open. 23 seedlings in the area with 12 leaves, measured on November 20th, 1915, gave an average height of 4·5 *ins.*; 26 seedlings in the area with no dead leaves, measured on November 19th, 1915, gave an average height of 6·6 *ins.* The rainfall at Dehra during July—September, 1915, was 63 *ins.* as compared with 28 *ins.* in 1913. This high rainfall, combined with the considerable side-shade, kept the seed beds continually wet and poorly aerated in 1915. Under these conditions, the dead leaves were probably responsible for an accumulation of toxic decomposition products and thus proved injurious.

7. There are two principal factors which seem likely to retard the germination of teak seed in the shade, *viz.*, soil aeration and temperature. On June 28th, 1915, 50 teak seeds from Burma were accordingly sown in porous pots filled with clean well-aerated sand, and placed under the shade of trees in the Dehra Experimental Garden. On the same date, 100 seeds were similarly sown and placed in the open. During the rains of 1915, one seed germinated in the shade (*i.e.*, 2 per cent.) and 29 (*i.e.*, 29 per cent.) in the open. *This suggests that temperature is probably the factor which chiefly* influences the germination of teak, but further experiments are required to prove this.

8. The results of the above experiments are summarised below :—

(1) Germination of teak is unsatisfactory under heavy shade and much inferior to that obtained in the open.

(2) Assuming sufficient moisture is available, the principal factor necessary for the germination of teak appears to be a fairly high temperature. In the forest this would depend chiefly on the type of soil and its water-content, the aspect and density of shade.

(3) Teak seed which had remained dormant in the soil for two years, under heavy shade, germinated rapidly when the shade was removed.

(4) An admixture of dead teak leaves in fairly heavy loam was beneficial to germination and the growth of teak seedlings when the soil was kept well-aerated and fully exposed to light and air, but was injurious when kept constantly wet. This would naturally occur under heavy shade in the forests, especially in districts of heavy rainfall.

(5) Seedlings produced in heavy shade are of inferior vigour to those developed in the open, provided sufficient moisture is available in the open.

9. The above garden experiments carried out in a single locality are of course far too incomplete to justify any generalisation but (apart from the danger of weed-competition) they do indicate the following probable advantages for a system of clear felling, at all events, in forests of the moist type where shade tends to be dense early in the rains, at the time when germination is required :—

(1) Provision of suitable conditions for early germination.

(2) Aeration of the soil and provision of suitable conditions of soil and light for the vigorous growth of the seedlings.

10. The most satisfactory natural reproduction of teak, resulting from a definite sylvicultural operation, seen by the writer in the Central Provinces, occurred in the Jubbulpore Division. In 1906, an area of mixed teak forest, some 2 acres in extent, was *clear-felled* in Block 46 of this Division in connection with a coppice experiment. Teak was the dominant species and associated with it were *Anogeissus latifolia*, *Ougeinia dalbergioides*, *Lagerstrœmia parviflora*, *Diospyros tomentosa*, *Nyctanthes Arbor-tristis* and others,

The cover in 1906 was close, with no grass or teak seedling growth on the ground. The teak showed an average height of about 38′ and basal girth of 3′. The soil was a heavy loam overlying trap rock. The area was again visited by the writer in February 1908, and the following points were then noted :—

(1) Although nearly two years had elapsed since the felling, grasses and weeds had not occupied the area to any extent and there were considerable areas of clean soil between the stools of the felled trees.

(2) Although exposed for nearly two years, the soil had not become hardened but was comparatively loose and crumbly and eminently suitable for plant growth. This favourable texture was, probably, partly due to good aeration and the decomposition of the organic débris in the soil.

(3) Numbers of teak seedlings of quite exceptional vigour had established themselves, subsequently to the felling, in the bare areas between the stools of the felled trees.

This, of course, is an isolated case and justifies no generalisation, for which far more extended observations and experiments are required. At the same time, so far as it goes, it is definite evidence of the favourable effect of clear felling on the natural reproduction of teak.

THE NATURAL REPRODUCTION OF SAL.

BY R. S. TROUP, I.F.S.

Mr. Hole's valuable paper in the *Indian Forester* of October 1915 on the natural reproduction of the *sál* throws much light on a difficult subject, and will prove of great interest and utility to practical foresters whose duty it is to carry out the regeneration of *sál* forests. There is, however, one factor not touched on by him which may have a considerable bearing on reproduction, namely, the effect, largely if not entirly mechanical, of a layer of fresh dead leaves such as is frequently found covering the ground

at the time the *sál* fruits fall. In order to test the effect of such a leaf-covering an experiment was carried out in the Sylvicultural Garden at Kaunli, Dehra Dun, in 1914 and 1915. Six plots were marked out, A to F, on each of which 1,000 ripe *sál* fruits were scattered in June 1914, three plots being under the comparatively dense shade of a bamboo plantation and the other three in the open exposed to the sun; the soil on all plots was identical, namely, a fertile loam. There was timely and plentiful rain from the date of sowing. Prior to the scattering of the fruits the condition of the respective plots was as follows :—

Under shade ...
- A Bare ground, hoed up.
- B—Unhoed bare ground on which a thick layer of dead *sál* leaves was spread.
- C—Bare ground, not hoed.

In the open ...
- D—As in A.
- E—As in B.
- F—As in C.

The subsequent history of these plots up to the end of 1915 is as follows :—

A and C *(Bare ground under shade. A hoed, C not hoed).*—The seed germinated well in both plots, the seedlings developing satisfactorily during the first rains and sending down long stout taproots with comparatively few lateral rootlets. A certain amount of mortality occurred owing to insects biting through the taproots. Dying back was general from November to March, no doubt owing chiefly to want of light, since seedlings near one edge of the plots where the light was stronger were more vigorous and showed less tendency to die back than throughout the remainder of the plots. By October 1915 there were 104 seedlings in A and 133 in C: they were by no means vigorous, the maximum height being 8 inches. All these seedlings were along the edge of the plots near the light; there were none in the denser shade.

B *(Under shade, on a thick layer of dead sál leaves).* Germination took place freely. When the rains set in the leaf layer soon became wet and sodden, the interstices between the leaves being filled with earthy matter brought by earthworms. To

outward appearances the development of the seedlings during the first rains was only slightly inferior to that in plots A and C. There was, however, a great difference in the root-systems. In plot B the taproots penetrated horizontally between the wet layers of leaves, deriving sustenance from the earthy matter there and sending out numerous long fine lateral rootlets, unlike the plants in A and C. The seedlings could easily be pulled up by the roots intact. In B, again, the roots were more liable to the attacks of insects than in A and C, and there was considerable mortality from this cause during the first rains. The taproots made great efforts to penetrate to the mineral soil but seldom succeeded. It was not until the rains were over that mortality took place on a large scale. The leaf layer dried up or became partly consumed by white-ants, leaving the roots without either nourishment or foothold, with the result that the seedlings died off in quantities, many falling over for want of support. By the end of December 1914 only 27 seedlings remained, most of them being round the edge of the plot where the leaf layer was scanty; their condition was poor. By March 1915 only 6 remained, and by July 1915 there was only one surviving seedling at the base of a bamboo clump where there was a bare patch in the leaf layer.

D and F (*Bare ground in the open. D hoed, F not hoed*).—There is little to remark so far as these plots bear on the question under investigation. The seed germinated and the seedlings developed normally. There was a certain amount of dying back in the winter owing to frost and less mortality from insects than in the shaded plots. By October 1915 there were 170 seedlings in D and 109 in F, the maximum height being 25 *ins.* in D and 27 *ins.* in F. There was nothing to choose between these two plots so far as the vigour of the seedlings was concerned, the soil evidently being sufficiently well aerated without hoeing. The vigour, as compared with the shaded plots (A and C), was remarkable.

E (*In the open, on a thick layer of dead sál leaves*).—A complete failure from the beginning. Most of the seeds hardly attempted to germinate, and those which did perished at

once owing to exposure to the sun. The lower layers of leaves soon became moist but the uppermost layer, exposed to the sun, remained dry except after a shower of rain.

Conclusions.—The conclusions to be drawn from this experiment, so far as it refers to the effect of a layer of dead leaves, are :—

(1) *In the open, exposed to the sun, sál seed falling on a layer of dead leaves fails to germinate, or if it does germinate it perishes rapidly.*

(2) *Under shade, with complete protection from the sun, sál seed falling on a layer of dead leaves germinates and the seedlings develop satisfactorily above-ground during the first rainy season, though the development is hardly so good as on bare ground; as regards the root system, however, unless the leaf layer is so scanty as to permit of the ready penetration of the taproot to the mineral soil, the roots spread horizontally through the interstices of the moist leaves, and when the leaf layer dries up in the ensuing dry season, the seedlings die off for want of moisture, the mortality being as much as 100 per cent. where the leaf layer is sufficiently thick and unbroken.*

When these conclusions are applied to actual conditions in the forest, it will be seen that the annual layer of fresh dead leaves may be a highly adverse factor so far as natural reproduction is concerned. There will, it is true, always be patches of bare ground varying in extent, but, on the other hand, there will generally be patches, either under shade or in gaps exposed to the sun, where the dead leaves have accumulated sufficiently to cause a certain proportion of failure in regeneration. The most practical remedy would be the burning of the leaf layer in areas to be regenerated whenever there is promise of a good seed-year.

As regards the plots not covered with a layer of leaves, the strong development of the seedlings on those in the open as compared with those under shade will be remarked: this merely exemplifies a fact already brought out by Mr. Hole, namely, that full overhead light is one of the ideal conditions for the development of *sál* seedlings on loamy soil.

NOTE ON "SPIKE" DISEASE IN SANDAL.

BY P. M. LUSHINGTON, I.F.S.

1. Though the question of "spike" has been on the programme of investigation by the Research Officers since March 1913, it has been ascertained that no progress has been made with the investigation of this disease. It seems, therefore, desirable to tabulate as far as possible, in a short note, what is known about this disease and kindred subjects.

2. It is believed that the disease is of comparatively recent origin. It was first described by Mr. McCarthy in 1902, and investigated and reported on by Dr. Barber in July 1902. At that time the disease had been prevalent in Coorg for some 4 or 5 years.

In 1898 I noticed a very large number of dead trees in Punachi of North Coimbatore and was unable to trace the cause of their premature death. A Working-plan prepared by Mr. A. W. Lushington showed four coupes to be worked in this area. There is no doubt that Sandal was thick in this locality at that time. Last year Mr. McCarthy found there was no Sandal in these coupes and thinks it highly probable that "spike" was the cause of this absence. This is of interest because the locality is isolated and very far removed from any known "spiked" area. The Sandal in the nearest localities Madeswaramalai, etc., is still unspiked.

3. In North Coimbatore in 1903 I observed "spike" for the first time at Germalam. The disease, if it came from an affected area, must have come from Mysore across the Biligiri Rangans (5,000 feet) from a long distance. From Germalam it spread to Bylur and Jadathadi Halla. The Gundal Valley was free of "spike" but is now affected. About this time, though somewhat later, I observed "spike" at Hassanur, which probably came to the affected area *viâ* Punjur. I also observed "spike" at Thattakarai on the Burgur plateau but not at Burgur or Thamarakerai. In 1903 the Ekkatur plateau was free from disease as also the Palamalai Hill. The progress of the disease since that year is not known to me, and it would be of interest if the local officers would publish their observations.

4. In the Southern Circle the disease was first discovered by Mr. McCarthy in 1912—a single tree in Jowlagiri on the path to the Anchetti enclosure *viâ* Nandimanglam, south-east of the Rest House. A considerable area in this locality is now infected. A rather larger infected area was found by Mr. McCarthy about four miles north-west of the Rest House and orders to clear out all trees, whether healthy or otherwise from this area, were given. The orders were imperfectly carried out and in December 1914, two infected saplings were found in this area. It has also been ascertained that the disease has spread eastward to the adjoining area. About two miles east of this locality I observed two diseased trees amidst healthy Sandal in December 1914. Up to 1914 it was believed that this Reserve was the only infected area in North Salem. The Reserve adjoins Mysore. In 1915 Mr. C. C. Wilson observed two infected trees in Tholuvabetta, a Reserve about 18 miles, as the crow flies, from the nearest affected area in Jowlagiri. All the intervening Sandal area is healthy. About 23 trees have now been found "spiked" in this locality. Mr. Latham has found a portion of Thalli Reserve affected. This Reserve lies about four miles north of Jowlagiri and adjoins Mysore.

A single "spiked" tree has recently been found by Mr. Latham in Mr. Inglis' garden in Salem about 60 miles south-east of Tholuvabetta.

As far as is known, there is no further attack of "spike" in the Salem District either in the Anchetti or Dharmapuri ranges of North Salem or in the Sandal-producing areas of South Salem.

5. In Trichinopoly District the first report of "spike" was made in April 1915 from the Jambuthu Reserve in the Kollimalais Hills. This report was made by Ranger Sundaravaradachari. Leaf specimens show that this is undoubtedly spike. Seventy-eight diseased trees were uprooted over an area of 120 acres and it was believed that the disease was confined to this area. Subsequent investigation by Mr. Rama Rao, District Forest Officer, showed that an area at Chelliapatti in the Kollimahis, ten miles away from Jambuthu, "spiked" area had probably been attacked first as there were hundreds of young saplings and poles killed out by the disease. Between these two areas the Sandal is not affected.

The diseased area in the Kollimalais lies at over 100 miles south-east from Tholuvabetta and some 40 miles south-east of the one diseased tree found in Salem.

Mr. Rama Rao believes that the disease has been prevalent in the Kollimalais for two if not three years.

6. A report has been received of "spike" occurring in Tinnevelly. This is not yet confirmed. If correct the area must be situated at some 200 miles from the Kollimalais diseased areas as the whole of the Trichinopoly and Madura Districts intervene.

7. I have entered into this part of the question at some length because I believe it to be of the greatest importance. The disease appears to be very infectious, as when once an area has been affected it rapidly spreads to the adjoining area and the actual area soon gets wiped out. Apart from this, the disease appears to be endemic. It is, perhaps, possible that spores of a fungus may be carried over intervening areas of forest whether Sandal or other forest areas, or the disease might be communicated in some way by a bird or strong-winged insect. But with the experience of Punachi, Tholuvabetta, Salem, Kollimalais and possibly Tinnevelly, the endemic theory appears to be far more plausible.

8. Mr. McCarthy has assured me that in Coorg the disease has been stopped by clearing a belt of all Sandal and ***Zizyphus Œnoplia.*** I attach great weight to such an opinion and am anxious to continue experiments in this direction though by no means convinced of its efficacy. The attacks in Salem and the Kollimalais seem to show that no amount of clearing can stop the spread of the disease.

9. I now wish to record a few notes concerning the disease which I believe contain facts which are either generally accepted or believed by officers who have made the investigations :—

(*a*) A "spiked" tree has never been known to recover.

(*b*) A tree is frequently attacked in one part but healthy in another. Mr. Mascarhenas states that if the diseased portions are cut off the healthy part quickly becomes affected. Mr. McCarthy does not accept this but is assured that the pruning of unhealthy branches does not stop the disease.

(*c*) Healthy young seedlings are frequently observed in areas which are badly diseased. Mr. McCarthy adds that a seedling under cover of scrub never gets diseased but is liable to the disease as soon as it gets its head above the scrub.

(*d*) If the roots of a "spiked" tree get damaged "spiked" root-suckers are produced.

(*e*) If a tree is dug out and root-suckers spring up they are "spiked" as a rule. Mr. Venkatarama Ayyar has, however, observed and photographed a tree which produced a healthy root-sucker on one side and a diseased sucker on the other.

(*f*) Mr. McCarthy has observed that the degree of spike in a tree is the same throughout the tree, thus if a further portion of a badly diseased tree becomes spiked it will not go through the early stages of the disease. The same phenomenon is observed when a portion of a spiked tree gets subjected to fire.

Mr. Rama Rao has noticed that the ends of the shoots die before the branchlets.

10. The following observations have been made in connection with "spike".—

(*a*) The "phyllody" in "spiked" trees is due to excess of starch in the stem, twigs and leaves—(Dr. Barber).

(*b*) Dr. Butler found no trace of fungus disease and could not infect healthy trees either with the refuse of diseased trees or even by budding.

(*c*) Dr. Barber says that in "spiked" trees the root-ends die and the haustoria are either absent or dead.

This observation has been generally confirmed by Mr. Rama Rao. In almost every case he found the rootlets dead and shrivelled up. In one case the rootlets were found bleached. In another case root fibres seemed to have been developed after the spike attack but had died off without root connection. In one case two live haustoria were found on rootlets, but in this case the tree was parasiting on the parent root.

(*d*) Apparently all roots of diseased trees were found to have scars from being parasited upon. This, however, is the case even with healthy trees. In one case a living haustorium was found on a spiked tree.

11. Observations on diseases on other trees which have an appearance similar to spike in Sandal :—

(*a*) "Spiked" *Zizyphus Œnoplia* is found almost universally. Mr. McCarthy believes it to be connected with "spike" in Sandal. Dr. Barber has, I believe, stated that it is due to a different cause, but I cannot find his observation. I do not think there is any connection between them. I noticed "spiked" *Zizyphus* in Palamalai (North Coimbatore) as long ago as 1903 and I believe the Sandal in that area is still unspiked. It is prevalent in the Chitteris of South Salem and the Javadis of South Vellore, though in both these Sandal tracts the Sandal remains healthy. Mr. Latham observed that the *Zizyphus* in Mr. Inglis' compound where the "spiked" Sandal was found was quite healthy.

(*b*) "Spiked" *Dodonæa viscosa* is prevalent in the Chitteris and also in the Kollimalais —(Mr. Rama Rao).

(*c*) "Spiked" *Pterolobium indicum* is found on the Kollimalais—(Mr. Rama Rao).

(*d*) In the Kollimalais Sandal has been found considerably attacked by *Viscum verruculosum*.

The root-ends were found in some cases dead but in others quite healthy with healthy haustoria connected with *Clausena*.

A CLASSIFICATION OF THINNINGS AND INCREMENT FELLINGS.

BY S. H. HOWARD, I.F.S.

At the present moment there are in the United Provinces, and probably in other Provinces, various sized areas of forest which are beginning to be treated under one of the Uniform methods. Thinnings, etc., are already being performed in many of the younger age-classes of these forests, and this work will no doubt increase greatly in the near future. As far as I know there is no standard classification of these operations in India, and I believe I am correct in saying there is no complete classification in tabular form in English, though Schlich's "Manual of Forestry" contains a partial one. There is no doubt that any trained forester can judge the intensity and kind of thinning required in a given area and can perform the operation, but different foresters may describe the same thinning by slightly different terms. It often renders descriptions of thinnings clearer if some standard set of terms is used. To show that this difficulty really does exist the following example is given :—

During the last two years I have had to examine a certain number of sample plots almost all instituted by trained officers, some made nearly thirty years ago, some quite recently. These plots are in pairs, the one thinned, the other unthinned. In the case of the thinned plot a "heavy thinning" was made. The term "heavy thinning" can mean at least two distinct operations, and on examination I found that at least *three* had been made under the one term "heavy thinning," *viz.*, what I have called in this classification a "heavy ordinary thinning," a "heavy crown thinning" and a "light increment felling."

Moreover in the near future it will be necessary for Divisional Officers to explain to their subordinates the kind of operation they wish to have performed in an area, and it may simplify matters a good deal if some standard classification is at hand for them to refer to.

Most countries in Europe and most provinces in Germany have tabulated thinnings in some form or other. All these

classifications amount to much the same thing and I give below the one which appears to me to be the simplest and clearest. If others will criticise this scheme and suggest alterations where they think fit, it may be possible to establish a standard classification for India

The following translations have been used :—

Niederdurch forstung is translated "Ordinary thinning" instead of the rather cumbersome phrase "thinning in the lower storey."

Hochdurch forstung is translated "Crown thinning" instead of "thinning in the upper storey."

Lichtungshieb is translated "incremennt felling." The literal translation "light felling" cannot be used, as "light felling" in English means something quite different to "lichtungshieb." "Felling for light" would do but is cumbersome, and as the object of this felling is simply to produce increment the term "increment felling" is used.

I have not attempted to define a thinning or an increment felling fully, only so much is inserted as is necessary to differentiate the two.

CLASSIFICATION.

The various trees on an area of even-aged high forest may be classified as -

I. *Dominating trees.*—This section includes all trees which form part of the uppermost leaf canopy. It contains the following classes of trees :—

(1) Healthy trees with a normal crown development and good boles.

(2) Trees with an abnormal crown development or badly shaped boles.

In this latter class are included -

(*a*) trees whose crown space is crammed by neighbouring trees ;

(*b*) badly shaped old advance growth ;

(*c*) trees whose general development has been faulty, *e.g.*, with double leaders, etc. ;

(*d*) thin and spindly trees ;

(*e*) diseased trees of all sorts.

II. *Dominated trees.*—This section includes all trees which do not form part of the uppermost leaf-canopy. These are—

(3) Dominated trees, which, however, are not yet actually under the shade of their neighbours and the leading shoots of which are, therefore, still more or less free.

(4) Suppressed trees, that is trees standing under the shade of their neighbours and with their leading shoots dominated.

(Classes 3 and 4 then may on occasions be useful for protecting the soil or helping to clean the boles of their more vigorous neighbours.)

(5) Dead and dying trees which are of no use either for soil protection or for cleaning the boles of neighbouring trees. Small and very badly suppressed trees may also be included in class 5.

N. B.—Under class 2 the trees referred to under (*a*), (*c*), (*d*) and (*e*) may also occur in the dominated section. There is, however, no need to designate them separately under any class except class 2 as it is classes 3—5 which usually disappear first in the thinnings.

Thinnings are mostly concerned with the removal of—

(*a*) dead and dying trees;

(*b*) trees which are being left behind in the struggle for existence;

(*c*) diseased trees;

(*d*) trees with poorly developed boles or crowns;

(*e*) misshapen trees;

(*f*) trees with good crowns and boles which are harming more valuable trees.

Thinnings may thus include trees falling under classes 2 to 5 either wholly or partly and, in exceptional cases, some trees of class 1.

The essential point about a thinning, however, is that *no lasting interruption of the leaf-canopy is created.*

Increment felling.—(Lichtungshieb) includes all trees of classes 2 to 5 even when they are vigorous and healthy and not doing

damage to their neighbours, and sometimes a greater or lesser part of class 1 as well. The essential point, however, is that a *lasting interruption of the cover is created.* This interruption always lasts a long period and usually most of the remaining life of the wood. It is, therefore, usually employed when some form of soil protection wood is to be introduced either artificially or naturally, *c.f.*, Eichenlichtungsbterieb.

THINNINGS.

The following kinds and intensities of thinnings may be formed :—

I. ORDINARY THINNING (Niederdurch forstung or Eclaircie par le bas).

(1) *Light thinning* (A grade).—This is limited to the removal of—

(*i*) dead and dying trees and very badly suppressed poles ;

(*ii*) diseased trees,

i.e., class 5 and a few of class 2.

This thinning is of little practical use and is seldom made except for the purpose of comparative research with regard to increment.

(2) *Moderate thinning* (B grade).—This consists in the removal of—

(*i*) dead, dying and much suppressed trees ;

(*ii*) suppressed trees ;

(*iii*) spindly trees, and branchy advance growth which it is impracticable or not desirable to prune or lop, and diseased trees,

i.e., classes 5 and 4 and part of class 2.

(3) *Heavy thinning* (C grade). This usually consists in the removal of—

(*i*) all trees of classes 5 to 2,

(*ii*) and some of class 1, in such a way that only good trees with nice crowns and well shaped boles remain as nearly as possible equally distributed over the area and with room on all sides for proper crown development BUT *there must not be a lasting break in the leaf-canopy.*

In the execution of B and C grade thinnings the following points should be noted :—

(*a*) In all cases in which holes would be created by the removal of dominating trees (probably class 2 trees), dominated and even suppressed trees (classes 4 and 3) should be left to cover the ground.

(*b*) In removing *sound* trees of class 2 with badly shaped crowns or boles the operation must be made with due regard to the stocking and condition of the whole crop.

II. CROWN THINNING (Hochdurch forstung or Eclaircie par le haut).

This consists in the removal of dominating trees with the object of caring for and encouraging a certain number of specially good trees. Only two grades are distinguished.

(1) *Light.*—This consists in the removal of—

(*i*) dead, dying and much suppressed trees ;

(*ii*) badly shaped and diseased trees, stems with double leaders ;

(*iii*) trees, the removal of which is necessary from a group in order to make those left more or less of even size.

It, therefore, includes class 5, a large part of class 2 and some of class 1, but *not* classes 3 and 4 which are left to shelter the soil and help to clean the boles of the selected trees.

The removal of bad advance growth, etc., if it is likely to cause too great an interruption of the cover, can be spread over more than one operation, but such advance growth should be rendered harmless by lopping or pruning.

(2) *Heavy.*—This grade is applied in order to favour a definite number of selected stems with the object of producing large timber. It consists then in the removal of all class 5 trees and any other tree which hinders the proper development of the selected trees, *i.e.*, class 5 and some of classes 2 and 1 but *not* classes 3 and 4.

This thinning is specially suited to crops nearing the end of the rotation.

INCREMENT FELLINGS.

I have already stated on page 4 that the essential point of an increment felling is that it *does* create a lasting interruption of the cover. More trees are removed than in the heaviest C grade thinning, in other words, the selected trees are left more or less isolated, and classes 3 and 4 are not left to cover the soil. The soil, therefore, is not supporting as many trees as it could support and, although the increment per tree is large, there comes a stage when the reduction in the number of trees more than counterbalances the increased increment per tree. Exactly where this point is reached is certainly not known in India. Experiments were being performed in Europe but the problem was not by any means solved in 1912 and probably is not solved yet. Moreover, other points such as the quality of the wood, the value of any underwood, etc., come in. This subject is still quite in its infancy, and I only insert the classification of these increment fellings to make the table complete not because there is any likelihood of such a felling being made in the near future in India. Moreover, these grades are only experimental and the second is known to be too heavy, as it passes the stage at which the increased increment per tree is counterbalanced by the decreased number of trees.

The grades are—

(1) Light.

(2) Heavy.

If the basal area of a wood excluding classes 3 and 4 is measured after a C grade ordinary thinning then the light increment felling removes 20—30 per cent. of that basal area and the heavy increment felling removes from 30—50 per cent.

I have not used the term "predominating trees" anywhere. The best of the dominated trees are sometimes designated as "predominating," but the distinction is needless as naturally whenever any dominating tree is felled the worst are taken and the best left.

THE CALCULATION OF AN APPROXIMATE FINANCIAL ROTATION.

BY S. H. HOWARD, I.F.S.

N. B.—All quotations from Schlich are taken from the 3rd edition published in 1905. The pages may differ slightly in other editions.

Some three years ago an article by Mr. Blascheck appeared in the *Indian Forester* called "A Plea for Economic Forestry." This was followed by several letters at various intervals. The article and letters contained two main lines of argument:—

(1) An attempt was made to show that the present rotation of deodar in the Punjab was not financially correct.

(2) The Government was urged to adopt the policy of working financially.

This created a good deal of opposition directed partly against the first point and partly against the advisability of the Government adopting the financial principle as the guiding one in fixing the rotation.

This present article is not concerned with the second point at all; no attempt is made to discuss whether the Government should or should not adopt the financial rotation, but an examination is made of the first point, *viz.*, whether there are or are not sufficient data available for the calculation of an approximate financial rotation.

(*N. B.*—In India in the Selection forests it is customary to substitute a minimum girth limit for a rotation. The term "rotation" is used in this article but this is intended to include the time taken to attain the minimum girth limit.)

The method put forward by Mr. Blascheck was, that if a certain volume "v" present at a given time were allowed to grow for a certain period so that it attained the volume "V" (*i.e.*, the volume increment being V—v) then, if the volume increment per cent. calculated with compound interest was, during this period, less than the per cent. which could have been obtained by investing the worth of the timber "v" in an equally safe investment, it would

be more profitable to fell the trees at the age (or girth) when the volume "v" was present than wait till this volume had amounted to "V."

Exactly the same method has been put forward to prove that it is more profitable in parts of the Haldwani Division to fell *sál* with a minimum girth of 5 feet than to wait till they become 6 feet.

In neither case has it been shown clearly *why* the formula adopted is a correct one.

Moreover the opponents of the method have never shown very definitely where it was at fault but have usually simply stated that they did not consider there were enough data for the calculation.

Apparently the formula on which the calculation is based is

$$p = 100 \left(\sqrt[n]{\frac{V}{v}} - 1 \right)$$

where p = the per cent. to be found.
n = the number of years in the period taken.
v = the volume at the beginning of this period
V = " " end " "

This seems to be an attempt to calculate the "indicating per cent." The usual formula for this calculation over a period of "n" years is

$$p = 100 \left(\sqrt[n]{\frac{Y_{m+n} + S - E\,(1{\cdot}0p^n - 1)}{Y_m + S}} - 1 \right)$$

This formula is made up as follows :—

A wood lays on three kinds of increment :—

(1) *Volume increment* which is the increase in volume caused by the growth of the tree.

(2) *Girth price increment* by which is understood the increase in value per unit of volume for an increased girth.

(3) *Market price increment* which is the increment caused by a change in the price of timber generally.

As examples—

If 1 c. ft. of timber from a 4 feet tree is worth Re. 1
and 1 " " " 5 feet " " Re. 1-2

This is a *girth price increment* of 2 annas a c. ft.

If 1 c. ft. from a 5 feet tree is worth Re. 0-8-0 in 1900
and 1 „ „ 5 feet „ „ Re. 1-0-0 „ 1915

This is a *market price increment* of 8 annas in 15 years.*

It is quite impossible to calculate "market price increment," but if average prices are taken over periods of years it can be and always is neglected.

The two important factors are—

(1) Volume increment.

(2) Girth price increment.

There is no need to go into the proofs of the formulæ for volume and girth price increment per cent. as they can be found in any text-book on forestry.

If however during a period of "n" years a volume "v" becomes "V," and if during the same period the nett value per unit of volume rises from "q" to "Q" then

the volume increment per cent $= 100 \left(\sqrt{\frac{V}{v}} - 1 \right)$

and the girth price increment per cent $= 100 \left(\sqrt[n]{\frac{Q}{q}} - 1 \right)$

The combination of these two increments less the costs incurred to produce the increase gives the real increase in value of the forest.

Let w = the value of an area, *i.e.*, the combination of both increments plus soil.

Let W = the value of the area after "n" years.

Then $p = 100 \left(\sqrt[n]{\frac{W}{w}} - 1 \right)$

Correct values for "w" and "W" must now be found. The value of the area in the year "m" near the end of the rotation is

* In India some confusion has arisen with regard to the correct terms to use for the 2nd and 3rd increments. "Price increment" has been commonly used for both 2 and 3. Schlich uses "*quality increment*" *for* 2 and "*price increment*" *for* 3. "*Quality* increment" is not a very happy term for No. 2 and "price increment" expresses it better but unfortunately "price increment" has become generally recognised as the term for the 3rd kind of increment. In order to avoid any confusion it has been suggested that in India the terms "girth price increment" and "market price increment" shall be used for Nos. 2 and 3 respectively and I have, therefore, used these terms in this article.

the selling value of the growing stock (which may be called the money yield in the year "m," *i.e.*, Y_m) plus the value of the soil, *i.e.*, "S."

In the year "m" then, "w" $= Y_m + S$

After "n" years "w" becomes "W"

The money yield in the year "m+n" is Y_{m+n}

The value of the soil is still "S"

The costs annually have been "e" and this accumulated for "n" years at "p" per cent $= \frac{e\,(1{\cdot}0p^n - 1)}{{\cdot}0p}$ but $\frac{e}{{\cdot}0p}$ is the capitalised value of the annual expenses which may be written as E

$\therefore$ total expenses incurred between the year "m" and "m+n" $= E\,(1{\cdot}0p^n - 1)$

$\therefore W = Y_{m+n} + S - E\,(1{\cdot}0p^n - 1)$

and so the current forest per cent. $100\left(\sqrt[n]{\frac{W}{w}} - 1\right)$

becomes by substitution $100\left(\sqrt[n]{\frac{Y_{m+n} + S - E\,(1{\cdot}0p^n - 1)}{Y_m + S}} - 1\right)$

This is an unwieldy formula to work with until figures are substituted for the letters. If however "n" is put equal to one year

$$\text{it becomes } 100\left(\frac{Y_{m+1} + S - E(1{\cdot}0p - 1)}{Y_m + S} - 1\right)$$

$$= 100\left(\frac{Y_{m+1} + S - \frac{e}{{\cdot}0p}\,({\cdot}0p) - Y_m - S}{Y_m + S}\right)$$

$$= \left(\frac{Y_{m+1} - Y_m - e}{Y_m + S}\right) \times 100.$$

It has been shown that the money yield "Y" is itself a combination of the volume, girth price increment, and market price increment per cents.

The formula employed by Mr. Blascheck and Mr. Collier, which was for a period and not for one year, only takes into consideration the volume increment. It therefore leaves out a good deal which goes to make up "Y" and everything else in the formula. On the face of it it is not very obvious how the results from the two formulae can be the same, and it seems a pity that some proof has not been put forward either by the upholders or

the opponents to show exactly why the simple formula was or was not correct as the case may be. The present article makes an attempt to show how a simple formula can be derived and what its worth is when obtained.

No doubt there are several methods of obtaining the same results, however as everyone is familiar with Schlich's Volume III, and probably possesses one, the figures and formulæ have been taken as far as possible from that book in order that any one can check them. It is a recognised axiom, that in a forest so long as the capital invested in a given wood is increasing in value at a per cent. higher than the general per cent, the wood is financially unripe but that when it has sunk to exactly the general per cent then that wood is exactly ripe. I do not attempt to prove this statement but I quote Schlich as my authority.*

The formula $p = \left(\frac{Y_{m+1} - Y_{m} - c}{Y_{m} + S}\right) \times 100$ is the commonest formula for the indicating per cent. and can be found on page 165, Vol. III, Schlich.

It should be noted that all these symbols represent money not volume.

The above formula which is familar to everyone is taken as a starting point.

It has been advanced against Mr. Blascheck's and Mr. Collier's proof that calculations based on single trees cannot be applied to the increment of whole woods, for which the above formula was evolved. Presumably this objection does not mean that the single trees do not give the proper volume and value increase. If it does mean that it would only necessitate basing the volume of the single tree used for the calculation on the average of a large number of measurements which I assume Mr. Blascheck did and which I know Mr. Collier did.

**Schlich, Vol. III, page* 191.—"As long as the indicating per cent. is higher than the general per cent. p, at which money can be invested otherwise with equal security, or at which money can be obtained for investment in forestry, the wood is financially not ripe; when the indicating per cent. has become smaller than p, *the financial ripeness* of the wood is past; the wood is financially ripe at the time, when the indicating per cent. is equal to "p."

It probably means that as the formula for the indicating per cent. is calculated for the unit of area and as it is not known in India how many trees should normally be on a unit of area that therefore the formula and others like it do not apply.

The above formula, however, applies to any unit equally well. It is used on the Continent with units of a franc and a hectare, in England with a shilling and an acre (see Schlich) and in India it could be used with a rupee and an acre or an anna and an acre. If therefore we choose our unit to be the area occupied by one tree *it still holds good even though we do not know what that area is, provided that the values for S and e are reduced in proportion.*

Moreover the above formula is usually used with a given number of trees, this number being the *same* in the year m + 1 as in the year m and in the case of a period the number may equally well be the same.

Let the volume of a tree in the year "m" $= x$

" " " " $m+1 = x'$

Then the increment $= x' - x$

and the increment per cent. $= \frac{x' - x}{x} \times 100$

It is obvious that if 50 or 100 trees were taken in each case the per cent. still remains the same.

It is true that in making the calculation over a period of years a thinning might have taken place the value of which would have to be added to the final value to get the correct value increment. If this thinning were correctly made, and necessary, it would not alter the question, and is, in any case, an unnecessary complication, as it is usually arranged, in order to simplify the calculation, that the thinning shall be taken out just *before* the period starts. This is so in Europe and it will be found that in the calculations of the indicating per cent. on page 197, Vol. III, Schlich, that the thinning is always avoided in this way and that the number of trees at the beginning and end of each ten-year period is the same. A point to notice however is that as some of the trees, which should provide the material for thinning, would not produce the best timber, they are not reckoned at the best price. This point will be referred to again later.

Nor does it make any difference that the area occupied by a 5 ft. tree and a 6 ft. tree might be and probably is different.

As already stated the unit is immaterial provided always that the S and e are reduced proportionally. If the units differ the S and e would differ in proportion (just as they do between an acre and a hectare) and the per cent. in each case would be a true one.

What is said about volume increment for the single tree applies equally to value as any one can prove who cares to work out the figures.

It is then now assumed that the formula—

$$p = \frac{(Y_{m+1} - Y_m - e)}{Y_m + S} \times 100$$

holds good for the single tree provided that tree is a fair average.

The argument is however more easily followed if it is taken for the unit of area as figures are then available with which comparisons can be made.

The above formula can be written in the form—

$$p = 100\left\{\frac{Y_{m+1} - Y_m}{Y_m + S} - \frac{e}{Y_m + S}\right\}$$

First consider the expression $\frac{e}{Y_m + S}$

In all the examples in Schlich—

$e = 3$ shillings an acre

$S = 404$,, ,,

Y_m varies with the age of the wood, but as this calculation is always made for fairly old woods (at least over middle age) it is always a large figure. On page 120, Vol. III, Schlich, there is a money-yield table for Scotch Pine. Taking the figures given there then

At the age of 70 years $Y_{70} = 2187$ shillings (the 134 shillings taken out as a thinning do *not* go on to produce increment).

$\therefore$ the expression $\frac{e}{Y_m + S} = \frac{3}{2187 + 404} = \frac{3}{2591}$ or roughly $\frac{1}{864}$

which is not a very large fraction to deduct from the rest of the expression in the bracket, *viz.*, $\frac{Y_{m+1} - Y_m}{Y_m + S}$

Moreover the older the wood the smaller the expression $\frac{e}{Y_m + S}$ becomes as Y_m is always increasing.

Anything which reduces "e" or increases "Y_m" must reduce the value of the fraction.

It makes very little difference then if $\frac{e}{Y_m + S}$ is rejected altogether even in Europe and in India where "e" is small and Y_m large (for 5*d.* a cubic foot is a very small price for valuable species like Sal or Deodar) the error is even less.

More than that the rejection of the fraction $\frac{e}{Y_m + S}$ makes the value of "p" larger than it should be. It therefore delays the time when the current forest per cent. sinks to the general per cent. or in other words *makes the rotation so calculated longer than the correct financial rotation.* The error is therefore on the safe side.

There is left the formula—

$$p = 100 \left\{ \frac{Y_{m+1} - Y_m}{Y_m + S} \right\}$$

Now comes the question of "S," the value of the soil. Anything which reduces the denominator of the above fraction must increase the value of the fraction, that is, increase "p," and thereby delay the time when the current forest per cent. becomes equal to the general per cent.

The error then of rejecting "S" altogether has the effect of lengthening the rotation and is therefore again an error on the safe side.

"S" is always fairly small compared with Y_m, and in India where "S" is certainly smaller than in Europe the error will be even less but what there is will be on the safe side.

It is hoped that it has now been shown that the formula—

$$p = 100\left(\frac{Y_{m+1} - Y_m}{Y_m}\right) \text{ is approximately correct.}$$

It has already been shown that the whole formula applies equally well to one tree (if it is typical) as to a whole wood. In practice exact measurements of the increase in value for one year cannot be made and the calculation is always made for a period of years. Exactly the same arguments apply over a period as have

been employed above. One year has been used in these theoretical arguments simply because the formula is very complicated and unwieldy for a period. In order to prove that this contention is equally true for a period the following figures are inserted:—

These show the current forest per cent. for a Scotch Pine wood calculated from the data on page 120, Vol. III, Schlich, assuming as is assumed in the book that—

S = 404 shillings an acre
e = 3 " "

General per cent. = 2½, *i.e.*, when the current forest per cent. sinks to 2½ then the wood is financially ripe.

The periods are ten years. Column 2 shows the approximate calculation neglecting S and e; column 3 shows the correct calculation.

The formulæ used are then—

$$\text{Col. 2: } p = 100\left(\sqrt[n]{\frac{Y_{m+n}}{Y_m}} - 1\right)$$

$$\text{Col. 3: } p = 100\left(\sqrt[n]{\frac{Y_{m+n} + S - E(1{\cdot}0p^n - 1)}{Y_m + S}} - 1\right)$$

Age.	Approximate calculation of p.	Correct calculation of p.
1	2	3
60—70	4·03	3·19
70—80	3·22	2·68
80—90	2·63	2·25
90—100	2·23	1·95

According to the correct formula the financial rotation with a general per cent. $2\frac{1}{2}$ is about 80 years. With the approximate formula rejecting S and e it is about 90 years.

This surely proves what I have said, *viz.*, that the rejection of S and e creates a small error, *i.e.*, 10 years, and that this error is on the safe side in that it makes the rotation 90 years instead of 80.

So far however the whole proof has been connected with the change in *value* of a wood over a given period.

It has been shown that the symbols Y_m and Y_{m+n} represent the selling value of a wood in the years "m" and "m+n" respectively.

It has also been shown that the change in value is made up of the volume increment and the girth price increment (market price increment is always neglected as stated).

$$\text{The volume increment per cent} = 100\left(\sqrt[n]{\frac{V}{v}} - 1\right)$$

$$\text{,, girth price ,, ,, ,,} = 100\left(\sqrt[n]{\frac{Q}{q}} - 1\right)$$

If these two per cents. are calculated separately and then added together the same result should be obtained as when using the formula—

$$p = 100\left(\sqrt[n]{\frac{Y_{m+n}}{Y_m}} - 1\right)$$

In actual practice by keeping the same number of trees all through the period (which has to be done in order to enable the argument to be based on single trees) some trees, which theoretically should have been removed in thinnings, will not fetch the full price, *i.e.*, their girth price increment will be less.

By neglecting this point and assuming *all* trees to get the full girth price increment a larger value "p" will be got than the correct one, *i.e.*, *this error* (the third introduced now) *again tends to lengthen the rotation.* As a result of this the argument which has been urged that this approximate method is incorrect because some of the trees would have been taken out in thinnings does not hold water, for any error thus introduced is small and is in any case an error on the safe side.

Because of this the figures now shown where the calculations for the volume and girth price increment per cents. are made separately and then added together should give a rather higher value for p (and consequently a longer rotation) than when using the approximate formula —

$$p = 100\left(\sqrt[n]{\frac{Y_{m+n}}{Y_m}} - 1\right)$$

As exactly the same data are used here as in the previous calculation and as the results of that are repeated it will be seen that the above contention is correct.

Age.	Volume increment per cent. $p = 100\left(\sqrt[n]{\frac{V}{v}} - 1\right)$	Girth increment per cent. $p = 100\left(\sqrt[n]{\frac{Q}{q}} - 1\right)$	[illegible]	Calculation on formula. $p = 100\left(\sqrt[n]{\frac{Y_{m+n}}{Y_n}} - 1\right)$ Col. 2 of previous table.	Correct calculation of p including all data. Col. 3 of previous table.
60–70	2·12	2·20	4·38	4·03	3·19
70–80	1·70	1·84	3·54	3·22	2·68
80–90	1·36	1·55	2·91	2·63	2·15
90–100	1·10	1·31	2·44	2·23	1·95

This gives the correct financial rotation for this wood with a general per cent. 2½ as 80 years. By merely calculating the volume increment per cent. and the girth price increment per cent. and adding them together and rejecting everything else the rotation becomes about 95 years.

In other words the rotation is some 15 years *too long* which is an error on the safe side.

N.B.—It should be noted that where girth price increment occurs then the volume increment per cent. alone gives a rotation too low.

Conclusions. From the above arguments I draw the following conclusions:—

(1) If the volume increment and girth price increment in any locality are known that gives sufficient data for calculating an approximate financial rotation. Measurements and calculations may be made on single trees. The formula would be—

$$p = 100\left(\sqrt[n]{\frac{V}{v}} - 1\right) + 100\left(\sqrt[n]{\frac{Q}{q}} - 1\right)$$

or it may be more simply written

$$p = 100\left(\sqrt[n]{\frac{Y_{m+n}}{Y_n}} - 1\right)$$

For girth price increment the easiest way to settle the question would be to auction a certain number of sound logs of various dimensions for a short period of years at some central place in each division.

(2) If girth price increment is absolutely non-existent and volume is all that matters and a cubic foot from a small sapling is worth as much as a cubic foot from a 6 feet tree, then the rotation corresponding to the culmination of the mean annual increment would be the correct financial rotation. The calculation of the current volume increment per cent. would give certain useful information, probably it would show how long the trees could be kept so that money was not actually lost, but as this is purely a theoretical case I have not worked it out. Girth price increment practically always exists to a certain extent for there is usually some stage at which it becomes profitable to saw a tree and below this size it is only fit for fuel, etc.

(3) A common case is that a certain class of scantling is sawn in a district which can only be got from trees above a certain size, *e.g.*, 4 feet. Below this stage the trees are more or less unsaleable. There is then perhaps a certain girth price increment (often connected with bark per cent. and wastage in conversion) up to say 4 feet 6 inches or 5 feet and after that none at all. In a case of this sort a calculation based on the value of the tree from when the girth price increment begins (*i.e.*, in our case at 4 feet) and continued on would show the correct financial rotation. The calculation based entirely on volume would not be correct, money must be substituted for volume, and in that case the girth price increment is automatically included so far as it exists and drops out when non-existent. It will be found in these cases that the financial rotation is usually very close to the stage at which girth price increment ceases.

(4) If there is a stage at which trees become saleable and below which they are unsaleable, but there is no girth price increment at all once the saleable size is reached, then a calculation of the volume increment per cent. made above the time at which the trees become saleable shows the correct financial rotation. It will be found however that this usually works out to be almost at the size at which the trees first become saleable, except in the case of a fast growing tree. In such cases forestry from the financial point of view is not as a rule a very profitable investment though it may be from other points of view.

RECENT PROGRESS IN CELLULOSE TEXTILES.

BY W. RAITT, F.C.S., CELLULOSE EXPERT ATTACHED TO THE FOREST RESEARCH INSTITUTE, DEHRA DUN.

Some of the readers of the *Indian Forester* may recollect that at a Foresters' gathering at Dehra Dun some two years ago, in the course of an address on the possibilities of an Indian cellulose industry, I ventured to indulge in a prophetic vision which must have seemed to my audience more visionary than prophetic. It ranged, if I remember rightly, from cellulose coffins to cellulose whiskey, from steamer steward's bad-weather basins to cellulose

suits—the latter being highly recommended as suitable in price to an underpaid but still deserving Forest Service. The scoffers then present will please take note that this article is written to convict them of sin, for it is the story of A Dream Come True. I cannot yet elevate them with $C_6H_{10}O_5$ whiskey—except at a price per drink which is beyond a forest man—but I can depress them with an offer to supply the coffin to any who feels he needs it, and I am at this moment wearing the cellulose garment, a toney thing with pink trimmings and surmounted by a distinctly elegant cellulose tie.

The origin of cellulose fabrics is but skin deep. It lies within everyone who has ever absent-mindedly twisted a strip of paper in the fingers or evolved a temporarily efficient rope out of a newspaper, and many of these experimenters must have had dim visions of a really efficient fabric *if* the paper was of sufficient tensile strength and sufficiently cheap. Hitherto strength in paper has meant a prohibitive cost. The Japanese have for centuries twisted short lengths of their beautifully strong *Broussonetia* paper, but until recent years nothing at once strong enough and cheap enough to form the basis of a commercially possible industry has been forthcoming. The Germans, with their talent for imitation which we are beginning to understand is largely their substitute for invention and originality, have for some years been producing hybrid fabrics of jute warp and paper weft and twines composed of two paper yarns twisted round a hemp core. In all such efforts the paper was merely a cheap make-weight. It never occurred to them that paper could be produced of such a quality that a fabric could be composed of it entirely and sold honestly and openly for what it is, until an Englishman, Fielding, showed them how to produce a sufficiently strong paper from wood. Its process of manufacture is a modification of the sodium sulphate digestion in which the digestion process is carried on at a temperature below that at which the cellulose is impaired in strength and is arrested at a point just short of that at which the ligneous binding material is completely resolved. Some of it, softened but not fully soluble, remains in contact with the pulp, is not removed by washing and

becomes a cementing agent when the pulp undergoes the process of being floated, felted, pressed and dried into a web of paper. The pulp is also treated by the "Kollergang" process where it is rubbed and bruised between heavy stones revolving on a stationary one. It is curious that such a simple and apparently purely mechanical process should actually produce a chemical change in the constitution of the pulp—a process of hydration which adds an additional molecule of water. Expressed empirically, the pulp is no longer $C_6H_{10}O_5$ but $C_6H_{12}O_6$. That such a change can be produced by such simple means gives us another glimpse into the extraordinary malleability and transformation powers of this apparently stupidly inert substance. Its practical effect is a great increase in the toughness and water-resisting power of the paper and the acquisition in a great measure of the qualities of parchment.

Hence "Kraft" paper (no, gentle patriot, not a hostile word *now*, but universal like Sauerkraut and Wagner) which solved two important problems: (1) cheapness, it being produced from one of our cheapest raw materials, and (2) tensile strength, it being from 40 to 50 per cent. stronger than the paper it supplanted.

There remained the mechanical problems attached to the conversion of a continuous web of paper into spun and woven goods. Germany, once again, went fumbling along with what she was used to in jute and hemp machinery producing, indeed, wonderful results in yarn and twists for sacking and other fabrics but at an unnecessarily high cost. Again it remained for an English firm to grasp the full possibilities of starting operations with a strip of paper which was in itself *a fully finished fabric* and not a loose agglomeration of individual fibres, and therefor permitting liberties to be taken with it in speeds and strains which are not open to the jute or hemp spinner. The result of this enlarged view is to be seen at the factory of The Textilite Engineering Co., Ltd., 78, Southwark Street, S. E., where machines are at work slitting and winding paper into narrow discs or rolls of 6,000 yards in length and 6 to 12 mm. wide and spinning it into yarns for twine and a large variety of woven fabrics at speeds twice those permissible to the spinner of raw fibres. The reduction in conversion costs is obvious.

To Mr. George Seaton Mildé, the Managing Director of the Textilite Engineering Co., is due the credit for this really marvellous step in advance. The business of the Company is the manufacture and sale of their patented machines and the factory at Southwark Street is only for experimental and demonstration purposes but on a sufficiently large scale to prove the commercial possibilities of the industry. In it he has a complete outfit of spinning and weaving machinery producing twines, sacking, matting, carpeting, braids webbing, tapestries, tailor's and milliner's sundries and cloth of various descriptions. The facility with which paper takes dye makes it possible to produce goods, such as carpets and tapestry in any pattern and design. The whole establishment is a revelation not only of what is being done but of what may be done, for there seems to be no limit to the purposes to which the material can be put and every day is adding to the number of uses actually accomplished. It is well worth a visit by any reader who may be proceeding Home on leave.

The obvious criticism is, will it stand wet? To the ordinary person whose only acquaintance with cellulose is in the form of news or writing paper, the question seems a very pertinent one, but chiefly because he does not realise that his newspaper (provided it is a *cellulose* paper and not a cheap ground wood one) *will* stand wet. He may bury it in the earth for months and it will not rot. Its fibres will have lost their cohesion by absorption of water, but if carefully handled and slowly dried, he will get his paper back to its original state almost uninjured. Put shortly, that means that cellulose is indestructible except by such drastic treatment as fire or acids. Cellulose will not rot because all the fermentable substances with which it is associated in nature have been removed in the digestion process. Jute and hemp will rot because these substances remain with them in the manufactured condition. The foundation of the industry then is a practically indestructible substance, so the above question resolves itself into, will its individual fibres cohere under the effects of wet? They will, and for two reasons, the first being the parchment-like character of Kraft paper which gives it a very high degree of resistance to water penetration, and the second

a waterproofing process to which it is subjected during spinning. I have with me a piece of cellulose hessian cloth which has been repeatedly immersed for days and dried. I have also a quantity of twine which has been used for tying up garden plants and therefore exposed for six months to rain, wind and sun. Neither are appreciably altered. In point of cost the industry is on an absolutely safe basis, and for two reasons, which no amount of prejudice can blind one to, first, the normal price of its raw material, paper, is £16 per ton against jute at £24 and hemp at £40; second, the fibre spinner starts with a loose fibrous mass which he has to reduce to a spinnable condition by the numerous and complicated processes of scutching, batching, carding, roving, drawing, all of which add to the manufacturing cost and produce much waste. The paper spinner cuts all these out, starts straight off with his paper strip, his waste is only 2 per cent. and his production owing to the high speeds possible is doubled. The nett economic effect can best be judged by recent quotations, *viz.*, Dundee jute yarn 5⅜*d.* per lb., paper yarn 3½*d.* per lb.

After the above, it seems advisable to add a word of consolation to our jute friends and that is, *no new textile has ever yet displaced its predecessors.* Each of them, as they appeared, found its own place and created its own market and cellulose will no more ruin jute than the latter ruined hemp. So cellulose and jute can quite happily run together. It *may* touch the jute *grower*—apparently he can afford it—but it cannot possibly hurt the manufacturer who would have little difficulty in using paper yarn either wholly or in combination with jute and thus have another weapon in his hands with which to argue with the grower. Wherefore, rush not to liquidate your jute shares.

One result of the Textilite Engineering Co.'s enterprise has been the recent establishment of Celltex Limited with a factory near Ilford to manufacture paper twines for which the war has created an extraordinary demand, due mainly to the ruin of the Belgian and Polish hemp fields and the embargo on export of Italian hemp. As soon as this Company has got into its stride, it intends establishing a similar factory in India. Its registered address is 25 Victoria Street, S. W.

For India the moral of this story of A Dream Come True may be laid down in the following propositions : —

(1) The Cellulose Textile Industry has got past its rocks and shoals and is now in the Latitudes of Plain Sailing.

(2) The addition of a *textile* to the present *paper* demand is likely to largely increase the world's requirements of pulp —and the supply is none too good for paper.

(3) India ought to be a pulp-producing country, it has all the natural advantages of a pulp-producer, and amongst these are enormous supplies of Savannah grasses yielding pulp of a quality specially suitable for textile purposes.

(4) Therefore, Let There Be Pulp.

Mr. Kutt is sending to the Forest Research Institute a collection of specimens of cellulose textiles for the Economist's Museum. These consist of Yarn, Twine, Cloth, Hessian, Sacks, Woolpacks, Carpets, Tapestries, Braid, Webbing, Tailor's Sundries, etc. We have been enabled to see some of these already and think that there can be no doubt that the Cellulose Textile Industry has come to stay. *Hon. Ed.*]

DRY DISTILLATION IN BURMA.

BY R. UNWIN, I.F.S.

Suggestions have recently been made by local experts that Ceylon possesses all the necessary materials for the production of Acetone, Acetic Acid and other products of allied nature, by the destructive distillation of wood and that the work should be started at once to supply the home markets.

Acetone is a valuable solvent which is used in the manufacture of explosives, so that apart from other motives it would be a great help to manufacturers of munitions to have a source of supply from one of our own possessions. If these arguments are sound in Ceylon where timber is so much scarcer, how much stronger they must be in Burma where wood is cheap; nay, where it has *no* value at all in many places. By "wood" I do not mean the valuable timbers which are worked commercially but the thousand and one kinds for which there is practically no use even as firewood once the big towns are left a few miles behind. I would not suggest working a forest for distillation but merely following up

the extraction of traders and others, utilising their waste branches, etc., and taking in hand accessible areas over which improvement fellings have been made. Such areas would last for several years and afford valuable information without encoaching on our forests at all.

In the large towns of Lower Burma such as Rangoon and Moulmein the fuel question is rapidly becoming acute and in all probability the charcoal produced by distillation would be readily saleable besides helping to solve the problem of fuel supply. As far as I know, no attempt has been made to distil wood on a commercial scale in India or Burma so why not have an expert on distillation as well as one for the paper-pulp. The already overworked Forest Economist cannot take up this enquiry and it would be a mistake to employ a Forest Officer with no special mechanical or chemical knowledge on this work. The Experimental Tannin Factory in Rangoon might have done well enough had it been permanently presided over by an expert. Once firmly established private firms would no doubt carry on the work.

Trade with Germany, who, as everyone knows, is a very large exporter of chemicals, is stopped and now is the time to try and get some part of their trade into our hands. Some of these chemicals can be turned out here. Ought we not as a department to try to develop production of those that fall within our sphere? In writing this note I make no claim to originality whatever but put forward a suggestion simply as one interested in such projects and because, at any rate, it has not been discussed in the *Indian Forester* in recent years at any rate.

GRASS PRESSES.

We have had the opportunity of perusing an interesting note on various grass presses, written by Mr. Nazir Abbas, E. A. Conservator, C. P., in which he deals with their merits and demerits, his conclusions being based on actual experience.

He will no doubt supply a copy of this note to any interested parties.

A NEW PROCESS OF WOOD PRESERVATION.

In our issue of July 1914 we printed an extract from the *Chemical Trade Journal* advocating a preservative treatment for sleepers, which consisted in impregnating them with a mixture of liquid paraffin silica and naphthaline.

The process claims easy penetration owing to the volatability of the oil, this, however, would be probably more than counter-balanced by the rapid evaporation from the timber, in other words, by the loss of the preservative. Under Indian conditions of climate we understand that the Research Institute does not consider the process to be of much promise, liquid paraffin and naphthaline being highly volatile, while silicates on trial have been found very difficult to introduce into timber. Experimental work at Dehra Dun with this process has, therefore, been discontinued.

QUINQUENNIAL REVIEW OF FOREST ADMINISTRATION IN BRITISH INDIA, 1909-10 TO 1913-14, WITH THE RETURN OF FOREST STATISTICS FOR THE YEAR 1913-14.

We propose to examine briefly the statistics of the year 1913-14 comparing them with those of five years previous, *i.e.*, 1908-09. For the first time the review has been published under the signature of the Secretary to the Government of India in the Revenue and Agriculture Department in place of that of the Inspector-General of Forests and is more concise than formerly covering 12 pages in place of 29.

The area of the forests under the Department is, to the nearest, thousand square miles, 1,080,000 as against 986,000 sq. miles in 1908-09, the increase being principally due to the inclusion of the Shan State forests; while the area of the reserves is 96,000 sq. miles as against 94,000.

It is not always realised that the total area of the forest lands covers nearly 23 per cent. of the area of British India—the percentage varies enormously in the various provinces and Administrations, thus in the Andamans it is 70 per cent., and 63 per cent. in Burma, while in the United Provinces it is only 4 per cent., in Bihar and

Orissa 3·4 per cent. and 1·4 per cent. in Baluchistan. These figures show no very great difference to those of 1908-09, except in Burma where the percentage has dropped from 76 to 63. It is difficult to compare those of Assam, Bihar and Orissa, and Bengal as the tracts included in those provinces have undergone considerable modification.

The total area under completed Forest Settlement stood at 117,000 sq. miles in 1913-14 as against 106,000 in 1908-09, while artificially marked boundaries showed an increase of some 2,000 miles, and areas over which a detailed survey has been carried out, an increase of some 7,000 sq. miles.

Passing now to Working-plans, the proportion of forest area under sanctioned plans is 22 per cent. as against 17 per cent. in 1908 09, the increase during the five years having been some 5,000 sq. miles. The percentage in the various provinces varies greatly, for instance, the United Provinces show 98 per cent., an increase of 4 per cent., while Burma shows 6 per cent., an increase of 1 per cent. There seems to be no doubt that greater energy is called for in bringing our reserves under Working-plans and the increase is to some extent disappointing, though it must be remembered that without an adequate establishment such work is much handicapped and what province can say that it has an adequate establishment? A Divisional Officer in Burma, for example, may have the charge of many thousand square miles, while a similar officer in Europe has, perhaps, 20 under him. Again the progress in Working-plans must depend greatly on the progress of Settlement and Demarcation, still the area under sanctioned plans is less than half the area where Settlement has been completed. The preparation of a Working-plan takes some time, but we think that at times such is spread over a longer period than necessary, for example, we have known some five years or more elapse between the time of sending in the preliminary report and the completion of the plan.

The progress made on buildings is fairly satisfactory—the figures of 1913-14 showing an increase of nearly 2 lacs of rupees on those of 1908-09. Good shelter for officers on tour in malarious districts is an economy in the long run, as are also suitable buildings

for the subordinate staff. The expenditure in 1913-14 was Rs. 8,43,000 as against Rs. 6,53,000 five years previously.

The expenditure on roads shows an increase of over 3 lacs of rupees, the figures being Rs. 8,49,000 against Rs. 5,40,000. This is to a moderate extent satisfactory but much more remains to be done. The Burma figures do not show out well, Rs. 90,000 on new work, some Rs. 22,000 less than five years ago, and less than was expended in Assam or the Central Provinces. In the latter the expenditure on such work has risen from Rs. 67,000 to Rs. 97,000. The great incentive to new roads is the extension of railways, to which roads act as feeders, and until Burma is better opened up with railways it seems doubtful whether adequate expenditure will be incurred on communications.

Comparatively little has been done in the way of mechanical transport, we may expect to see early developments, however, in the United Provinces, where a Forest Engineer has just been engaged for a term of years. Other Provinces might well follow suit.

Breaches of Forest Rules show an increase of some 50 per cent. on the figures of 1908-09: in this respect Madras and Bombay have an unenviable notoriety though the percentage of increase is not as great as in the Bengal Presidency.

The figures of the two years under comparison are :—

		1908-09.	1913-14.
Bengal Presidency	...	24,000	38,000
Madras Presidency	...	22,000	31,000
Bombay Presidency	...	16,000	23,000

The reason for the large number of offences in Madras and Bombay is probably the Forest Policy of the past in these Presidencies. This consisted in making over to the Forest Department and reserving innumerable small tracts of country, many of them of little value as forest, difficult to protect and a frequent cause of friction with the people. We imagine that the sooner many of these are disafforested and made over to the Revenue Authorities the better it will be for all concerned. A glance at the map accompanying the Review will explain our meaning.

Appendix XIII shows an area of 50,000 sq. miles as fire-protected, the area in the corresponding form in 1908-09 is not shown but was probably some 2,000 sq. miles less.

The percentage successfully protected was 96, 1,997 sq. miles having been burnt against 1,913 sq. miles five years previously.

In Madras 15,000 sq. miles were under protection, in the Central Provinces 11,000 and in Bombay 10,000 sq. miles, in other Provinces less. The heaviest incidence of fire occurred in Madras, Assam and Bombay. Thus in Madras 7·1 per cent. of the area under protection was burnt, 4 per cent. in Assam and 3·9 per cent. in Bombay.

In Madras the causes of 762 fires burning 397 sq. miles of country were undiscovered, in Bombay of 969 burning 185 sq. miles and in Burma and the Central Provinces of 106 fires burning 28 and 81 sq. miles respectively.

The remarks made at the end of the preceding para. under breaches of Forest Rules explain probably the large number of fires in Madras and Bombay.

The opinion is rapidly gaining ground that fire-protection in India at any rate in the moister localities is being overdone and if not actually harmful, is certainly not worth the expense. In some localities it may be actually harmful, *e.g.*, in parts of Bengal, Burma and Assam the regeneration of the more valuable species after years of protection is not as good as it was years ago when a fire was rather the rule than the exception.

We well remember several years ago an Assam Forest Officer of some 20 years' service telling us that he had never seen a fire-line till he came to Northern India and if he were returning to Assam did not wish to see one. This was, perhaps, an exaggerated view, but still it serves to show that the belief in fire-protection as a remedy for all ills was not universa. in the past, though every endeavour was made to inculcate this belief. There is no doubt that the Sal forests of Northern India have made a magnificent response to fire-protection, while the inverse is the case in similar forests further east. The sooner these facts are faced the better, though it takes many years for Forest Officers to get rid of ideas

instilled into them in their early training and reason out cause and effect themselves.

A problem affecting the well-being of the forests as greatly as fire-protection is how to regulate the grazing demand.

In 1913-14, 43,600 sq. miles out of an area of 249,000 sq. miles were closed to all grazing, against 41,200 sq. miles out of 248,000 sq. miles in 1908-09.

Grazing and successful reproduction are incompatible, and the latter has often to give way to the former. The writer has often heard the idea expressed that the one object of forests is to supply timber and fuel. This is an entirely wrong assumption, the supply of adequate grazing may at times be of greater importance than that of timber and fuel and instances can be quoted of wooded growth being cut out with the express purpose of improving the supply of grass. This may shock the sensibilities of Forest Officers fresh from European forests, but gives expression to the policy of the Government of India that the forests are being maintained and improved for the benefit of the people in the first instance, a policy incontestably right when one considers the enormous pressure that there is on the land—the benefit of the people may be in the matter of timber and fuel or grazing, each case must be settled on its own merits.

In 1913-14, 6,618,000 cattle grazed at full rates while 3,540,000 grazed at reduced rates making a total of 10,140,000 grazing on payment against 11,427,000 similarly grazing in 1908-09, while 4,305,000 as against 3,334,000 grazed free under recorded right or at the pleasure of Government. The total number of cattle grazed in 1913-14 was thus 144 lacs as against 147 lacs in 1908 09, while in the former year no less than 43 lacs out of 147 lacs grazed free. We commend these figures to those who cavil at the policy of the Department and who assume that this policy presses heavily on the people. In no other country in the world would this amount of grazing be provided at very low rates or free of all rate. It has often struck us that the revenue of the country would be raised considerably without causing undue hardship by doubling the grazing rate. We believe that the ordinary rate paid for a bullock or cow is from 4 annas to 8 annas for a whole year.

The tendency that will in the near future show itself in Forestry in India will be towards plantations as an aid to natural reproduction, in some places such may even supersede natural reproduction. At present there are but 225 sq. miles of plantations scattered among our forest areas, an increase of some 2 sq. miles on the figures of 1908-09. We have done nothing towards creating plantations to meet the requirements of various industries, and if several of these are to be successful in India, the wood required for them must come from plantations. The sooner this is realised the better, and the sooner plantations of suitable timbers are begun for such industries as matches, tea-boxes, bobbins, etc., the sooner will India be independent of foreign countries. At present the country is flooded with matches from Norway and Japan, with tea-box shooks from Norway, with bobbins from abroad. Japan is moving to cut out the European supply, while sleepers are being imported from America, and Japan again is looking into the question of a possible trade outlet for Japanese timbers suited to railway requirements.

Apart from the commercial side of the question it is notorious that certain of our forest tracts are very difficult to regenerate naturally, and that we must have recourse to artificial regeneration. In the next 50 years we expect to see as much attention devoted to plantations as has been devoted to fire-protection in the past half century.

We wonder if Forest Officers have any idea as to what the outturn of our forests is in timber and fuel. In 1913-14 it would appear that this was 2,946 lacs of c. ft. as against 2,320 lacs in 1908-09. The incidence per square mile varies enormously, 19,806 c. ft. in the North-West Frontier Province to 276 c. ft. in Baluchistan, the average outturn per square mile being 1,200 c. ft. as against 960 c. ft. in 1908-09. Besides this a large quantity of timber and fuel is left in the forests for want of means of cheap transport or of suitable markets, while in rare instances are the forests being worked to their full possibility.

The outturn of minor forest produce in 1913-14 was worth 108 lacs of rupees, this apparently includes bamboos, while in 1908-09

it was worth 69 lacs, presumably excluding bamboos: the value of the outturn per square mile varied from Rs. 282 in the Punjab and Rs. 213 in the United Provinces to Rs. 2 in the Andamans and Rs. 6 in Burma. The average value per square mile was Rs. 44 in 1913-14 as against Rs. 29 in 1908-09. The low average in Burma shows that a country probably the richest in minor forest products of any province in India is still untapped.

We commented upon the vast number of cattle that the Government allows to graze free—this liberality is further emphasised by the large quantity of produce given away free. It is estimated that no less than 670 lacs of c. ft. of timber and fuel is thus disposed of, showing an increase of 94 lacs in the last five years, while minor produce, of the value of 39 lacs of rupees, is given away as compared with 20 lacs worth five years ago. The total value of forest produce thus given away is estimated at 74 lacs of rupees as against 46 lacs five years since.

We again commend these figures to those who imagine that the forest policy of the Government of India presses hardly on the people. What private owner would benefit his tenants to the same extent ?

We now pass to the income of the forest In 1913-14 the gross income was 329 lacs of rupees, in 1908-09 it was 255 lacs. Of this timber accounted for the greater portion, *i.e.*, 253 lacs and 192 lacs respectively.

The expenditure of the year was 171 lacs, out of which administration cost 85 lacs or just half.

In 1908-09 the expenditure was 147 lacs, administration costing 68 lacs.

The above figures are taken from Statement XVII, which deals with the forest not the financial year.

We are glad to see that the expenditure on communications and buildings showed an increase of some 4 lacs, while expenditure on cultural operations, plants, etc., was also increased, though in both cases we consider that considerably more money might have been allotted with advantage.

In order to show at a glance the financial aspect of the Indian Forest Department during the last quarter of a century, we extract the following figures (these are for financial years) :—

	Revenue.	Expenditure.	Surplus.
1893-94	... 177 lacs	... 93 lacs	... 84 lacs.
1898-99	... 190 „	... 100 „	... 90
1903-04	... 222 „	... 122 „	... 100 „
1908-09	... 254 „	... 147 „	... 107 „
1913-14	... 333 „	... 175 „	... 158 „

In other words, the net revenue has nearly doubled in the last 25 years. The most noticeable increases are in the United Provinces, the Central Provinces and Bombay, few officers outside the latter Presidency realise to what extent the work of the Department has there developed and expanded. After reading the review of the Government of India with the statements attached to it, we think that we may fairly congratulate the Chief Conservators and Conservators in the various provinces on the excellent results shown.

We feel, however, that what has been done is only a beginning and that much more remains to be done and we offer the following suggestions to the various provinces to which their energies may well be specially devoted :—

(1) The extension of Working-plans.

(2) The concentration of working rendering on the one hand supervision easier and ensuring higher prices, while on the other cultural measures and aids to natural regeneration can be carried out with far less difficulty.

(3) The opening out of the forests by roads and buildings—and roads are specially called for where the neighbourhood is being tapped by a railway as feeders to this railway. Markets follow railways, thus they will also follow feeder roads.

(4) Extension of mechanical means of transport.

(5) Extension of plantations irrigated and unirrigated to supply the public with cheap timber, minor products and fuel, the cheaper the fuel the less call will there

be to burn cow-dung, which will then be available to enrich the soil. Also plantations to meet special industries, such are non-existent.

(6) Greater liberality in fostering commercial enterprise by laying down at Government expense sample plants on a commercial scale for special industries so as to introduce these to the public, where to date the public has failed to come in, such as pulp factories, match factories, creosoting plants, each under the control of a specially engaged expert.

The above points have been too much neglected in the past, not from want of energy on the part of the Department but from want of officers and want of money. The Department has been for years stinted in men and money.

Indian Forest Administration has been decentralised during the last few years and each Province is now to all intents and purposes self-contained and independent. A little rivalry and competition among the Provinces would hurt no one and would not be out of place, though industrial and commercial progress must greatly depend on circumstances outside the control of the Department, *e.g.*, the opening up of the country by railways and a cheap supply of chemicals, some of which might very possibly be produced within the confines of the Indian Empire.

We conclude our remarks by saying that the increasing prosperity of the Department is in great part due to two guiding hands—one that of Sir St. Hill Eardley-Wilmot to whom the Department owes a debt of gratitude which it would do well to realise, and the other that of Sir Robert Carlyle whose interest in the welfare of the Department and recognition of the work done by it were doubly welcome after too frequent periods of official neglect in the past and want of sympathy with the aims and objects of Forest Officers.

It is noteworthy that during the five years that cover Sir Robert Carlyle's tenure of office, Forest Officers have figured more frequently in the Honours' list than during the whole of the half century preceding.

EXTRACTS.

WOODEN ROADS.

Experiments have been made with various materials for our Indian roads. The ordinary macadamised road that is so excellent in England is far from perfect in the tropics. The fierce showers of the tropical monsoon are strong enough to wash out the gravel, and the muddy roads during the rains are succeeded by roads with many cracks when the fierce sunshine that follows the fierce rains has dried up the mud. There has been a good deal of talk about paving Indian roads with blocks of wood; and, in Calcutta, people have been in the habit of pointing out the fact that a small area in Clive Street that was thus paved some years ago has shown excellent results. Before the recent monsoon, therefore, it was resolved to make the experiment on a considerably larger scale in Hastings Street, and this was accordingly done.

The Chief Engineer in the course of a report says that the experiment is going to be a failure. In a country like India, where there are alternate periods of very wet weather and very dry weather, timber, of course, alternately expands and contracts, so when the wooden blocks were laid down in the dry weather that preceded the rains, it was, of course, realised that they should be a little apart from one another with an "expansion-joint" to hide the crack, thus leaving the blocks room to expand when the rain came. The rains have come, and the Chief Engineer writes :—

"The expansion-joint at the sides is already used up for all practical purposes, and that in less than two months. The Executive cannot be blamed for this, as I pointed out what would happen to wood-pavement to the committee which sat some years ago to consider the question of the best road surface."

This is all very well, but we should be inclined to ask whether the Executive is not to be blamed for having allowed insufficient room for expansion. The matter is of much importance, for it would be a great pity if the experiment were to be quoted for all time as a failure, if, in reality, the failure is due to an imperfect calculation. As it is, the blocks will begin to push up at an angle as soon as they meet, whereas, with a further allowance for expansion, they might have lain flat throughout. The word "failure" should not be writ too soon. The Chief Engineer explains the success of the earlier experiment in Clive Street by saying that the wood there is teak, which is non-absorbent of water and does not therefore expand to any appreciable extent. Teak was not abnormally expensive when that little area was blocked, but the price of teak since then is prohibitive.

Rubber has not yet been tried seriously, and is for the present out of the question in the East, but tar macadam, such as has been used so successfully on Madras roads, is an excellent preventive of the dust nuisance, and a serviceable material. Its slipperiness is a drawback, but it gives good roads.—[*Madras Times.*]

SEMUL OR SILK COTTON.

Semul or Silk Cotton is well known in the United Provinces. It is extremely light and has a remarkable power of water resistance. From an experiment conducted in the Government Horticultural Gardens of Lucknow it would appear that *semul* has a life-saving property also, and might be utilised in making life-buoys. A tubular belt of oil-cloth, seven feet long and five inches in diameter, was stuffed with four pounds of "silk cotton," the ends were sewn up and strings attached for fastening the belt to the body. A man weighing 132 pounds was let down one of the deep wells in the gardens and it was found that the belt not only kept him suspended in the water with ease, but he was able to carry at the same time in his hands a dead weight of twenty pounds.—[*The Indian Textile Journal.*]

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THE COMMERCIAL SIDE OF FOREST WORK IN INDIA.

BY R. S. PEARSON, I.F.S.

Forest work naturally falls under two main heads, both of equal importance, firstly the work entailed in growing and tending the crop and secondly the disposal of the mature product. The former may be termed the technical and the latter the commercial side of the business, it is to the latter that this article refers. Many years ago the State inherited a valuable property of forest and waste land, Government very wisely made it its business to develop this. At the commencement the work was carried out on a modest scale, and expenditure was necessarily limited. Gradually the work increased, as a larger staff of trained men became available. Their energies in opening up and developing the forest estates necessitated greater expenditure, this resulted in a corresponding increase of revenue, and work continued along fairly normal lines until the present day. Before discussing the commercial side of the work it is necessary to review the condition of the forests at the time the Forest Department took over charge and also the training of the men who had to carry out the work of establishing, protecting and exploiting these forests.

Wire-Ropeway in the Punjab, Bashahr Division, erected by Mr. Donald, *vide* article entitled "Two Wire Ropeways" in *Indian Forester*, February, 1915.

Fig. 1.

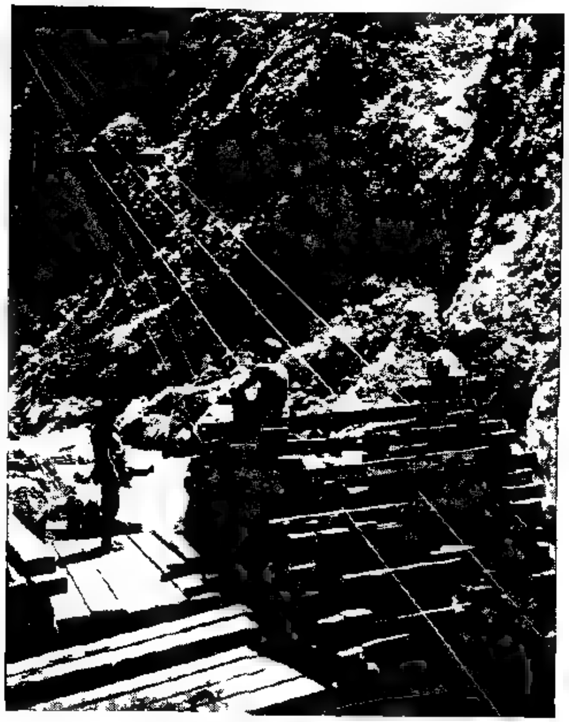

Photo.-Mechl. & Litho Dept. Thomason College, Roorkee

Lower terminal of ropeway below Ramni. Just over 3000 feet in length, showing a load of B. G. sleepers approaching platform.

Fig. 2.

The Barang ropeway 3000 odd feet. Taken from top of lower platform and showing (on left) a second span of 2 "Fixed ropes" working from same forest.

It would be ancient history to review in detail the condition of the forests 50 or 60 years ago, their condition varied greatly according to their composition, their proximity to possible markets and the ease with which they could be exploited. For the purpose of this article it is sufficient to state that in many instances they were much damaged and over-exploited. At the same time nearly all of the forests were undemarcated, communications were bad or non-existant, no inspection bungalows existed and maps were either very bad or more often not available.

From what has been said above it will be clear that the work with which the first Foresters in India were faced was one of great *magnitude affording unlimited scope. We now know that they* and their successors tackled the difficulties before them in a way which deserves nothing but praise. Much, however, remains to be done, both on the technical and commercial side, so that it is necessary to consider if all is well and whether the business is being run on sound commercial lines.

We must first turn to the man who has had to do the work. The Government of India, having defined their forest policy, soon found it necessary to employ trained Forest Officers. They recruited the first three from Germany, after which they set to work to train probationers in France, later at Coopers Hill, and now at the Universities. These men came out to India and at once began to put their technical knowledge into practice, and as the forests placed in their charge were in a neglected and often ruined state, all their energies were concentrated on protection work, on forming reserves, demarcation and survey work, putting the forests on a sound legal basis, opening them up, building inspection bungalows and finally dividing up the property committed to their charge so as to facilitate the introduction of proper management, based on sound sylvicultural principles. This has been a work of the first magnitude and importance, but there is always a but it has had to be carried out in a marked degree at the expense of the commercial side of the business. Some people, not well acquainted with the conditions and work of the Forest Department, may say that they cannot follow the argument, though they probably will do so after

studying the numerical strength of the Forest Department lists in the various provinces, at the same time bearing in mind that roughly one-fourth of British India is under the management of the Forest Department. There is also another factor to be considered which has no doubt retarded the commercial devolopment of the State forests and that is that the Forest Officer's training is bound to be largely of a technical nature, as there is not sufficient time during this training to pay much attention to the commercial side of the business. I do not wish in any way to infer that the basis of training as carried out is on wrong principles, that is not the point, but as it takes several years to train a Forest Officer, either in his technical work or on the commercial side, and as there is not time to teach both subjects thoroughly, the latter had necessarily to give way to the former. The result of this is that not only have Forest Officers no great commercial knowledge but their sympathies and inclinations veer strongly to the technical side, in opposition to the commercial side of Forestry as a whole.

Now if the above principles be accepted, how can these difficulties be overcome? To curtail the period given to the technical training in Europe in order to give more time to the commercial side is out of the question, the time devoted to technical training is already too short as it is. The most satisfactory solution would be to employ a certain number of business men to carry out the commercial work of the Forest Department. This has in fact already been tried on a limited scale, as for instance in the United Provinces, where a non-Forester has been appointed to look after and manage the Government Rosin and Turpentine Factory and a manager appointed to the charge of the creosoting works. Or again may be cited the instance of teak sales held by professional auctioneers for the Forest Department in Burma. I would go further than this, and advocate the appointment of permanent men not only to look after sales of timber and minor products but to endeavour to find new markets for those forest products not at present exploited, to improve existing forest industries and where possible start new industries. This virtually amounts to local Economists, whose primary duty would be to carry out the routine

trade work of the Forest Department, and at the same time improve and expand the business along sound commercial lines, in which field there is a large scope in nearly every province.

It might reasonably be asked what would be the special duties of such officers. This would depend on the local conditions in each province, in some instance no such commercial men are required, in others there is great scope for the business man, as for instance where large timber depôts exist and sales have to be held at stated intervals, which, to carry out to the best advantage, entail a knowledge of ruling prices, causes of fluctuations in rates and the demand for different species of timber for special purposes outside the district. Then it very often happens that a serviceable timber well adapted for general or special industries is not on the market for various reasons, the local Forest Officer often makes attempts to find a market, but cannot do so as he cannot leave his district, in other words do the work of "bag man." Again for a Forest Officer to further or start an industry is practically out of the question, unless he has charge of an exceptionally light division, a practically non-existant article in British India. Often and often has it been proved that quite a sound industry could be started or an existing industry pushed, or a timber or minor product collected and put on the market, the local Forest Officer being fully aware of this but unable to take it up, and why, because he has other more important technical duties to attend to.

Another side of the question which daily comes before any one who has to deal with enquiries from firms, and which presents a nearly insurmountable difficulty as matters now stand, is to obtain supplies of seasoned timber, of special species, for a given purpose, at short notice. Say for instance that a special timber is wanted for rifle stocks, or welding hammers, or bobbins, or bottoms of ballast trucks, etc., it cannot be procured. Were commercial men in charge of the supplies it may be taken for granted that supplies would promptly be forthcoming, not only would there be a great expansion in the indigenous timber trade, by which Government would profit handsomely, both directly and indirectly, but the trade would be kept in the country, avoiding the necessity of

relying upon foreign sources, a reliance that might cost us dear should transport not be available or prices be unduly put up against us.

Let us consider for a moment what would happen were the State forests to fall into the hands of a large commercial company, empowered to run the business, and given the trained Forest Officer to carry out the tending and maintenance of the forests. Would they ask the Forest Officer to carry on the commercial side in addition to his own duties? The answer is of course in the negative, they would employ a staff of business men to dispose of the various forest products and take very good care that they were placed on the market in the most attractive and paying form.

To the above proposals will at once be raised the objection that the Government policy is not to interfere with private enterprise. That is just my point in advocating that the commercial work of the department should be carried out by business men, whose duty would not be to do the work that firms are willing to do, but to do the work which the firms will not do or in which they require a lead, in other words, to be a go-between between the trained Forest Officer and the commercial world. That such an arrangement would benefit Government and its Forest Department and also the commercial world admits of no doubt.

In the event of such a scheme being considered, it would be necessary to go into it in detail, for it is obvious that for some localities the above arguments are not applicable, while in others they apply with full force, and vary generally, in direct proportion to the value of the forest as a whole. One point, however, must be continually borne in mind when considering such a policy and that is that money makes money, and without a liberal policy of expenditure to render productive capital—in this case the State forests—it is absolutely futile to appoint a staff of commercial men unless they are properly and judiciously financed, so as to enable them to develop the enormous wealth of some of our Indian forests.

WORKING-PLANS IN BURMA.

BY H. C. WALKER, I.F.S.

There are, undoubtedly, differences between one working plan and another, and it is on this account that the Research Institute has classified our working-plans into two or three main types with several well-defined species.* But in practice these differences are ignored, and it is almost the invariable custom to work entirely by area, even when the working-plan directs otherwise, and within the areas, allotted to girdle, with the usual exceptions of seed-bearers, etc., all trees over the minimum girth limit. We are, therefore, I think, justified in assuming that for all practical purposes there is only one type of working-plan in Burma.

Any one who has girdled over areas for which no working-plan has been drawn up must realise what a great advantage it is that girdling should be regulated under a definite scheme. The reasons are that a working-plan ensures a working circle being gone over thoroughly and systematically within a period of years sufficiently short to prevent great deterioration and sufficiently long to allow an adequate number of trees becoming available for the next period. It ensures the work being distributed uniformly, and provides a regular yield throughout the period. It also supplies a rough but useful estimate of the number of trees to be girdled and probable outturn. At the same time no provision is made for future years beyond the period, and the question I propose to discuss, therefore, is whether a general scheme should be drawn up for the whole rotation.

For a European forest a working-plan is usually divided into two parts. The first part consists of a general scheme for the whole rotation, and is drawn up for the purpose of equalising the periodic yields. The second consists of a detailed programme of fellings, and is drawn up for the purpose of equalising the yields during the period.

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* Indian Forest Records, Vol. I, Part IV.

Take the following example :

Age-class.				Area in acres.
Over 60	...	...	...	700
40—60	...	...	...	600
20—40	..	...	...	300
0—20	..	...	...	400
		Total	...	2,000

In this case if the woods were cut over when mature, as is done in Burma, 35 30, 15 and 20 acres would be cut over annually during the four periods, and the yield would be most irregular. For such a forest a general scheme would be essential, and a simple and suitable arrangement would be to cut over 600 acres during the first period and 500 during subsequent periods, and to prescribe what woods should be allotted to each period. A detailed programme could then be drawn up for the woods allotted to the first period to ensure equal yields throughout the period.

The text-books lay great stress on the importance of ensuring "a steady and sustained yield," and give one clearly to understand that it would be considered most unsound to restrict the working-plan to one period. But although I have specially looked up the question, I am unable to ascertain what steps are supposed to be taken in the case of uneven-aged woods such as are almost universal in India. However, theoretically the problem is simple. As the age is not known, the stock must be enumerated by girth or diameter-classes, and having determined the length of time for the average tree to pass through each class, the girth-classes must be converted into age-classes. It is necessary also to determine what proportion of each class will reach maturity. Results would then be obtained such as follows, when a general scheme could be drawn up on similar lines as for an even-aged forest :—

Age-class.				Number of trees calculated to reach maturity.
Over 60	...	...	..	7,000
40—60	...	...	...	6,000
20—40	...	..	...	3,000
0—20	...	...	...	4,000
		Total	...	20,000

Thus 6,000 trees could be allotted to the first period and 5,000 to subsequent periods, and a Professor could then conclude by stating that such a scheme would tend gradually "to lead the forest over into the normal state."

Whenever valuations are made for working-plans in Burma, it is the practice to make enumerations of the younger classes and to determine the rates of growth. Such statistics are utterly useless for the purpose of regulating the yield of trees during the first period, or for providing an estimate of the trees to be girdled. They are, in fact, of no use except for the purpose of preparing an estimate of future yields. From the records it is evident that our predecessors took it for granted that the age gradations were irregular, and I have no doubt that originally these statistics were *collected with the intention of drawing* up a general scheme for the whole rotation in the manner described. No method of determining the number of trees which would survive to maturity was devised, and it was probably realised that on this account the calculations were of little value ; and at the same time, when actual statistics had been collected, it was not improbably found that the age gradations were not nearly so irregular as had been expected. In any case, if it was the original intention to draw up a general scheme, the intention was not carried out ; and nowadays apparently the only reason why statistics relating to the younger classes are collected is because it is the established custom.

I have, perhaps, not made it clear why the girth-classes must be converted into age-classes. For various reasons it has been decided to fix the minimum girth limit, which is practically the rotation at seven feet. Assuming that this corresponds with an age of 155 years which is the average for Burma, and that the period is 30 years, the yield for the first period will consist of trees over 155 years. The yield of the second period will consist of trees ranging from 125 to 155 years, the third of trees ranging from 95 to 125 years, etc. As it is necessary to compare one periodic yield with another it is useless making enumerations unless the girth-classes are converted into these particular age-classes. This can be done by plotting the results on to a diagram. Having determined

the number of trees of ages 125—155, 95—125, etc., it is further necessary to ascertain what proportion of these trees will survive to maturity, and this is usually considered the principal difficulty. The problem is, however, a simple one if the following facts are taken into consideration.

In the case of man it is a matter of common knowledge that the birth-rate and rates of mortality are constant. It follows, therefore, that the population of any country or locality must be arranged in what in Forestry is called "a normal series of age gradations," and must form a rough actuarial table from which the natural normal mortality can be calculated by simple subtraction.

As a matter of interest and for purposes of comparison, I have prepared an abstract of the actuarial table given in Whitaker's Almanac :—

Age.			Numbers.	Mortality.
90—100	...	...	23,638	...
80—90	...	...	397,828	374,190
70—80	...	...	1,648,139	1,250,311
60—70	...	...	3,389,924	1,741,785
50—60	...	...	4,799,894	1,409,970
40—50	...	...	5,800,473	1,000,597
30—40	...	...	6,498,089	697,616
20—30	...	...	6,953,465	455,376
10—20	...	...	7,256,479	303,014
0—10	...	...	7,848,457	591,978

It is, I believe, generally accepted—and the explanation certainly does not originate with me—that the facts referred to are the outcome of the struggle for existence—using the term in a wide sense. Thus man may be said to be waging an incessant struggle with disease, and is not exterminated nor is complete immunity established, but during the course of centuries a stable equilibrium is established, with the result that disease annually exacts the same toll of life at the same periods of life.

It is, I believe, also generally accepted that these laws apply to all species which undergo a natural struggle for existence, and therefore we may, I think, assume that they apply to the natural

forests of Burma and to all species in them. It is unnecessary, however, to rely entirely on theory. In the case of teak it is possible to test these views with statistics for an area of over 6,000 square miles. In Mr. Troup's "Teak Forests of Burma," Indian Forest Records, Vol. III, Part I, Appendix II, there is shown the average number of teak trees in each class, per 100 acres, in every teak-bearing working circle in Burma. If these statistics are examined, it is found that the age gradations are graduated in the regular manner one would expect on this view. Moreover it is well known that the mortality in the youngest class is very great, and here again one finds, as one would expect, that the numbers in the fourth class are small as compared with those of the fifth class.

Although it is a general rule that species undergoing a struggle for existence maintain a stable balance, yet in the case of man there is frequently a steady increase or decrease in numbers. Similarly in one respect teak is peculiar, or perhaps it would be more correct to state that there is this further difference between the two species, that whereas in the case of man one rate of mortality can be applied to all classes, yokels and townsfolk, peers and navvies, in the case of teak the rates vary considerably according to the species with which it is associated and the conditions of the locality. For instance, on shallow soils, where the lack of moisture results in poor growth and thin cover, the light-demanding and not very exacting teak may reproduce itself very abundantly, but the seedlings and saplings lack vitality, and therefore suffer heavy mortality in later years. In another locality, where a rich sandy loam results in luxuriant growth, far less reproduction may take place in comparison with the number of seed-bearers, but a larger proportion attain marketable dimensions. In these two cases it is certain that the rates of mortality will be entirely different. In examining Mr. Troup's statistics therefore it must be borne in mind that the rates of mortality do vary fairly considerably in different localities, and that one cannot expect to find the girth-classes graduated in exactly the same proportions in different working circles. Nevertheless, in one and

the same locality, where the conditions remain unchanged for indefinite periods, the rates of mortality must remain constant, and therefore, when an enumeration is made of a growing stock of teak, one may assume that the stock is arranged in a normal series of age gradations, and forms a fairly accurate actuarial table for that particular locality.

I have, on several occasions, put these views forward, but have not succeeded in getting the question taken seriously. The average Forest Officer is quite prepared to admit that the incessant struggle between man and disease results in rates of mortality so constant that insurance companies can make the most accurate and precise calculations, but although teak in our natural forests has had to undergo an equally severe struggle for existence, and although each successive generation has had to experience the same conditions, it is not admitted that the rates of mortality are constant. During our course of training it is thoroughly ingrained into our minds that a normal series of age gradations is what an unsophisticated layman would call abnormal, and is an imaginary state of affairs which could only occur in an ideal forest. Even if the age gradations are irregular in every artificial forest of Europe, it does not follow, even theoretically, that the same state of affairs must rule in the natural forests of Burma. Over forty working-plans have been made, and when one finds that the younger classes invariably exceed the older classes, and moreover by amounts which one must admit correspond roughly to the amounts of mortality, one would expect, it seems to me that we should reconsider our preconceived ideas and alter our theories to accord with the facts.

The following is a typical growing stock of teak, being based on Mr. Troup's averages: —

Girth class.	Girth.		Corresponding age.		Number of trees.
	Over 7′	...	Over 155	...	7,000
	6′—7′	...	130—155	...	5,000
	4½′—6′	...	90—130	...	10,000
	3′—4½′	...	58—90	...	17,000
	Under 3′	...	Under 58	...	61,000
			Total	...	100,000

These girth-classes are so large that it is difficult to convert them into age-classes. However, the following table probably shows approximately how the trees are arranged according to ages, and assuming that the age-classes are normal, the number of trees which will survive to maturity and amount of mortality :—

Period.	Age.	Number of trees.	Survivals.	Mortality.
	Over 185	2,000	2,000	..
	155—185	5,000	5,000	...
	125 155	6,050	5,000	1,050
	95—125	7,500	5,000	2,500
	65 95	13,650	5,000	8,650
	35—65	23,000	5,000	18,000
	5—35	36,000	5,000	31,000
	Under 5	6,800	...	...

The method of treatment is entirely different for a normal forest and one in which the age gradations are irregular. In the latter case it is essential to equalise the periodic yields I have, for instance, given an example of irregular age gradations in a selection forest, and no one could, I think, dispute that in such a case the number of trees to be felled should be restricted in some periods in order to counterbalance deficits in other periods. In all the older working-plans the yield was regulated by volume, *i.e.*, the number of trees was rigidly prescribed, and at the present time, although no attempt is made to equalise the periodic yields, a careful enumeration is made of the younger classes, apparently in order to make certain that the supply will be sufficient to maintain the yield.

On the other hand, if one can assume that the age gradations are normal, one is justified in regulating the yield by area, and it is significant that this has gradually become the established practice as the result of practical experience. There is also no object in enumerating the younger age-classes, at least for the purpose of equalising the periodic yields or merely to satisfy oneself that the supply is more or less adequate. When the age gradations are

normal, it is, however, possible to calculate the natural normal mortality as in the example given. Much of this morality is due to the fact that the trees have not sufficient room for development and could be prevented. It is possible therefore to determine within certain limits what effect a proposed sylvicultural operation would have on future yields. For instance, in the example given the yield of the second period could not be increased by more than 1,050 trees, whereas the yield of the sixth period could be increased up to a maximum of 31,000 trees. Although it is indicated, therefore, that we should concentrate our energies more especially on the enumeration of the older trees with a view to obtaining as accurate an estimate as possible of the trees to be girdled, it is also very useful to obtain some information concerning the relative proportions of the trees in the younger age-classes.

As the girth-classes have to be converted into age-classes it is desirable that very much smaller classes should be taken. At present also, it is the practice to classify all trees over 7 feet in girth as first class trees, but in my opinion it would be desirable to divide these trees into two classes corresponding roughly to mature and overmature trees.

Taking the above facts into consideration, the following organisation would, I think, prove suitable. Usually nine enumerators are employed, and I would suggest that they should enumerate trees only over 4½ feet in girth, in four classes, 4½–6 feet, 6—7 feet, 7—8 feet and over 8 feet. As enumerators are notoriously untrustworthy, I would make the coolies mark trees of the first and third classes with one notch, and trees of the other two classes with two notches. The officer in charge would then be able to check whether a tree had been overlooked or wrongly classified.

As soon as a working-plan is brought into force, a considerable increase of establishment is required, and I would suggest that as soon as the valuations are taken in hand, two deputy rangers should be appointed on the permanent establishment. These men could be employed on recounting sample plots, and in addition could enumerate trees in the younger age gradations. The classes I would suggest are for one man, foot classes up to 8 feet and a class

for trees over 8 feet, and for the other man the following classes, over 8 feet, 7—8 feet, 6—7 feet, $4\frac{1}{2}$—6 feet, 3—$4\frac{1}{2}$ feet, $1\frac{1}{2}$ 3 feet, and under $1\frac{1}{2}$ feet.

Trees above $4\frac{1}{2}$ feet in girth are comparatively few in number as compared with those below this girth—the average for Burma being 22 trees as compared with 78. Large trees also are more readily seen, and therefore the ground has not to be quartered so closely. If most of the enumerators were employed, therefore, to count only trees over $4\frac{1}{2}$ feet in girth, the work could be carried out very much more rapidly and economically, and if the work were checked as suggested, the estimate of the trees to be girdled should be more accurate. At the same time, although comparatively few statistics would be collected concerning the younger age-classes, the gradations would be more complete, and one should obtain a much clearer idea of the relative proportions in these classes.

It is usual to assume that the number of trees to be girdled will not be the same as those found at the time of enumeration and complicated calculations are made to determine the difference. Usually very little allowance is made for mortality, and as it is calculated that nearly half the second class trees will have attained maturity and have become available for girdling, it follows that the number of first class trees will be considerably greater towards the end of the period than at the time of enumeration. On this reasoning it is only logical to assume that the number of large trees of species other than teak would increase in exactly the same proportion, and in fact, that towards the end of the period the cover would be very much more dense and the forests more fully stocked. Such calculations seem to me to be palpably absurd. Although a forest may appear to be very open, especially in the hot weather, on my view it must be completely stocked and unable to contain more growth, and therefore, although undoubtedly many trees which at the time of the enumeration were under 7 feet must attain maturity before the end of the period, yet, I think, one may assume that this increase is counterbalanced by an equal number joining the throng of *aulenatthats*, and that for practical purposes the age gradations remain unchanged. Such an assumption would greatly simplify the calculations.

As regards other minor matters connected with working-plans, I would suggest that for the sake of uniformity one period should be adopted throughout Burma in all future plans. In existing plans the period varies from 15 to 40 years, and is sometimes justified on the grounds that it is a submultiple of the rotation, or because it is estimated to be the length of time for all second class trees to attain maturity. In my opinion the principal considerations in selecting a period are to ensure sufficient time to allow an adequate number of trees to attain maturity without causing great loss owing to mature and overmature trees deteriorating in value; and I consider a period of 30 years very suitable, and one which should be adopted in all future plans.

In addition to the classes based on girth, it has become the practice to form classes based on quality. Thus we distinguish between "sound and unsound," "yield and non yield," "marketable," "trees girdled for sylvicultural reasons," etc. I have no idea what object is supposed to be attained by these distinctions. So long as the yield is regulated by area and the number of trees is not prescribed, it is unnecessary to classify trees into "yield and non-yield." When timber is extracted, timber firms, I believe, usually measure and classify the timber on arrival at the floating stream, and therefore, if information is really required as to the quantity and quality of timber obtained from each compartment, the lessees could be asked to supply it, and the information would be more accurate and detailed than that collected by the miserable girdling or working-plans officer.

Control is made more efficient by avoiding unnecessary complications. These quality classes make the girdling reports and control forms very complicated, and render a comparison between working-plan estimates and actuals of trees girdled very difficult, and as they fulfil no useful purpose they should, I think, be abolished. On the other hand, there is room for considerable improvement in the estimates. Errors can arise in two ways: on account of careless enumerations, or because the sample plots selected are not typical of the compartment. As regards the first, the girdling officer can, if he has a record of the sample plots, always note separately

the number of trees girdled and trees left in each sample plot, and can prove whether the enumerations were carefully made or not. If, however, it were found that the estimates were faulty because the sample plots were not typical of the area, the girdling officer, who goes over the ground very much more thoroughly than the working-plans officer, could record on the divisional maps where sample plots should be taken when the next plan is made.

It would be a great advantage if the boundaries and numbers of compartments were printed on the maps. In my opinion the division of a working circle into compartments should depend entirely on the natural features and drainage, and therefore it might be possible to arrange that the compartments should be selected by the Survey Department before the maps were printed.

In order to save delay, it is also worth while to consider whether it would be possible to carry out valuations at the time when an area is being surveyed. My suggestion is that an enumerator should be attached to each survey plane-tabler, and when a suitable area had been enclosed, an enumeration should be made. When finished, the enumerator would rejoin the surveyor, and his coolies would help in clearing another line. In this way sample plots of 100 acres or so would be obtained uniformly throughout the area. The Survey Department could probably arrange to calculate the area of each sample plot, and the calculation would be more correct than at present. I have, however, not sufficient knowledge of survey work to determine whether such a scheme would be practicable.

Many of my criticisms and suggestions may seem unreasonable and far-fetched, but everyone must, I think, admit that there is room for considerable improvement in the present type of plan, and that a discussion would be useful.

FIFTY YEARS OF FOREST ADMINISTRATION IN BASHAHR (PUNJAB).

PART II.

BY H. M. GLOVER, I.F.S.

Part I has dealt with the early history of the forests, and the first attempts at replacing rough and ready methods by more scientific management.

First regular Working-Plan

The first regular Working-Plan was completed in July 1892 and dealt almost entirely with the deodar forests, blue pine being exploited only when its removal benefitted the deodar.

The division was divided into administrative units corresponding to the present range charges for which separate felling-series were made. The gradual change in the character of the forests on ascending the Sutlej Valley has already been mentioned, the deodar forests increasing in extent as the drier regions are approached, while the rate of growth varies enormously, being very rapid in the lower valley and extremely slow in the upper semi-arid tracts. Consequently the rate at which the deodar reaches exploitable size varies greatly. The annual yield was calculated separately for each felling-series, the period of recurrence of the fellings being based on the state of regeneration in individual forests and the period necessary for the smaller girth trees to attain exploitable size, a first class tree being taken as one of over 6 feet 6 inches in girth at breast-height. The existing stock of second class trees was badly in deficit, being only half the number of first class trees, while younger trees were very scarce.

For ten years previous to 1892 some 2,300 trees had been felled annually and the Working-Plans Officer considered that these numbers could not be maintained and reduced the yield for export roughly to 1,500 first class deodar per annum. Before the plan, exploitation had gone on in the more accessible forests for several consecutive years and wear and tear had been considerable. The Working-Plans Officer hoped to reduce this by prescribing selection fellings and also regular regeneration fellings separated at intervals

of from 10 to 20 years, and expected that regeneration would establish itself naturally in the interval and that there would be less need for artificial operations to replace the growing stock. He reduced the intensity of the fellings and ruled that care should be taken not to open out the crop too much, and noted that he would have liked to reduce the yield still further had not financial considerations been important. He prescribed improvement fellings in the young crops, roads, bridges, etc., but was limited in his prescriptions owing to the reduced financial yield, consequent on his restriction of the number of trees to be felled annually. He anticipated that the division would be run at an annual loss of Rs. 4,800 during the currency of the new plan but hoped that a small profit would perhaps accrue as the stock of timber in the sale depôts was unduly large.

Results of 1892 Plan.

I do not propose to comment on this Plan in detail and it will be sufficient to say that the fellings were generally so light that deodar regeneration failed to establish itself. There are still many mature woods in the drier regions in which fellings under the 1892 Plan had been made and which have not again been gone over and in which the results are absolutely nil.

The financial results were better than expected, some Rs. 40,000 a year being the nett surplus.

Revised Working-Plan.

In 1903 a revision of the Sutlej Valley Working-Plan was commenced by Messrs. Hart and Gibson, Deputy Conservators of Forests. This revision partook of the nature of a completely new plan, as it more than doubled the yield of deodar, involved the working of part of the blue pine forests of the Nogli range, besides prescribing far more works of improvement and development.

It was held that during the previous ten years the forests had been far too lightly worked to allow of the establishment of natural regeneration, while during these ten years it had been found that areas which had previously been considered inaccessible could be worked at a profit.

These proposals naturally enhanced the prospective revenue of the Division and allowed of a corresponding increase in the scale of works of improvement, the annual amount allotted to Roads and Bridges rising from Rs. 1,600 to Rs. 25,000, to Buildings from Rs. 2,000 to Rs. 6,000, to Thinnings, Sowing and Planting, and Fencing from Rs. 1,100 to Rs. 6,000. An increase in the staff was imperative and suggested establishment charges rose from Rs. 34,400 to Rs. 53,000 per annum.

Generally, schedules for works under A heads were drawn up and embodied in the prescriptions of the Working-Plan, and it may be noted that these definite tabular statements have greatly facilitated control, whereas suggestions of the Working-Plan not included in these schedules have usually been lost sight of.

Fellings.

Forests of the dry region unlikely to respond to systematic treatment were placed in a separate Working Circle and require no comment, and the following remarks will apply entirely to the main Working Circle in which deodar is the predominant species.

The fellings are nominally classed as " Selection " but partake of the nature of regular regeneration fellings for all blocks of high forest. The ordinary selection and final fellings over established young growth present no difficulty, but regeneration fellings are not so easy. Mature trees are felled in gaps and, at the first fellings, not less than two-thirds of the total number prescribed for the period of the plan are taken. This felling is followed by a long rest period—in the case of the drier forests 20 years, and 15 years elsewhere. A considerable latitude is allowed to the marking officer and fellings at times approximate to the " Shelter wood compartment " system.

Departmental exploitation was carried out until about 1907 and the outturn of all the more accessible forests was extracted in log along rolling roads and slides, often constructed in the roughest country, sleeper works being confined to the more inaccessible portions of the forests. From 1907 onwards, traders have extracted practically the whole of the outturn in the form of sleepers which are sawn in the forest, consequently the amount, always considerable, of felling débris has increased enormously. This débris, the

irregularity of seed years which occur after every three or four years, and mistakes in marking have at times prevented the subsequent regeneration of felled areas.

Regeneration.

The general results are, however, satisfactory and deodar regeneration is by no means deficient; but it is now recognised both in Bashahr and generally in the Punjab that it is unsafe to rely entirely on unassisted natural regeneration. For several years in Bashahr it was thought sufficient to clear the débris, sometimes combined with hoeing of the soil near seed-bearers, but in late years the areas have been more thoroughly treated. The best results would appear to follow burning of débris and brushwood, deep hoeing, and subsequent sowing in patches. Some of the most unpromising areas have been successfully treated in this way. It may be noted, however, that, after some 50 years of intermittent effort, almost complete failure has resulted from attempts to restock areas laid waste by traders before the lease. It will soon be necessary to revise the felling schedule according to the amount of established regeneration and greater attention will have to be paid to the rapid opening out of the overwood.

But little has been done to establish fresh deodar woods except in blue pine forests. The blue pine favours the growth of deodar and in places blue pine woods have been converted into promising deodar forests by sowing, planting, and subsequent removal of the overwood. Work of this nature has, however, been restricted in recent years owing to the rise in price of blue pine timber for which there is now a fair market. In the Pabar range, however, where the fungus *Trametes Pini* is common on blue pine, work of conversion to deodar still continues; while deodar is also introduced after the main "Group" fellings of the new plan. Round areas under regeneration barbed wire fencing is extensively used and has replaced old wooden fences, there being some 42 miles of fences in the Division.

Of species other than deodar regeneration is excellent and blue pine woods are extending rapidly. Silver fir and spruce have not been worked except for occasional experiments for special

50 Years of Forest Administration in Bashahr.

Fig. 1.

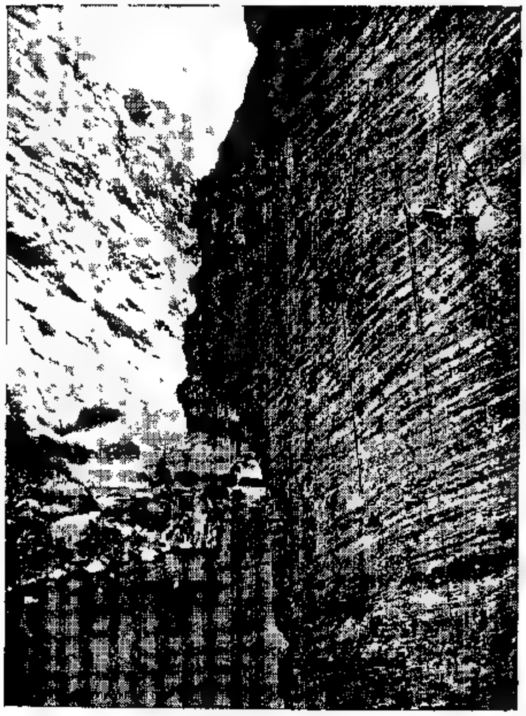


Fig. 2.

Fig. 3.

Photo Mech. & Lith. Dept. Thomason College, Roorkee.

ROAD-MAKING IN MAIN SUTLEJ VALLEY

purposes. A spruce forest has, however, been marked in regular regeneration fellings for exploitation during 1916, and should its extraction at last prove to be financially profitable, more extensive working is contemplated.

Thinnings, etc.

One of the most important prescriptions of the Plan is that concerned with minor improvement fellings and thinnings, especially where deodar is extending in blue pine woods. All young woods are gone over regularly, at intervals of 5 to 15 years, to the extent of some 7,000 acres yearly, causing the greatest benefit to young deodar. As already mentioned, there were practically no young deodar woods at the commencement of the lease ; consequently regular thinnings are still in their infancy, while minor improvement fellings are most essential in all young woods.

Roads and Bridges.

Ten years ago, the communications of the Division were in a very backward condition. During the last 11 years an average amount of Rs. 27,000 has been spent on roads and bridges of which the greater part have been built by the Forest Department. Contributions have been made to the Public Works Department for the upkeep and realignment of the Hindustan-Thibet road and for bridging the Sutlej in several places with strong suspension bridges where forest roads crossed the river. One large suspension bridge over the Pabar was built by the Forest Department. Except for two or three years, when works remained in abeyance owing to financial conditions affecting the whole province and to the lack of establishment, very considerable progress in road construction has been made, especially during the last four years when 70 miles 19 chains were built. The roads consist of bridle-paths 6 feet wide and of maximum gradient 1 in 8. Owing to the precipitous nature of the country of which the accompanying photographs (Plate 12, figs. 1—3) give some idea, much blasting has to be done, it being recognised that well-graded roads on main routes are essential. The standard of work is high, many subordinates being thoroughly efficient road-builders and being glad to be put on work which saves them much profitless wandering in steep jungles, despite the fact that fatal accidents

are not infrequent, no less than three forest guards having been killed on the first three miles of the road shown in the photographs. The cost is naturally high, roads in average bad ground costing Rs. 1,000 per mile exclusive of the price of explosives which are paid for separately. Roads running through bad cliffs cost double this amount on the worst sections. In places where suspension bridges have not been built, the Sutlej is crossed by a "Jhula," or wire-rope on which runs a pulley supporting a seat, an improvement on the old rope Jhulas carrying a wooden saddle to which one still has occasionally to trust oneself.

Buildings.

An average amount of Rs. 8,000 has been spent on buildings. There are houses for all rangers at head-quarters and occasionally houses for foresters. Guards, although often provided with houses, generally sponge on someone in the nearest village. There are now 18 forest rest-houses of which 12 have been built in the last 10 years, and a winter head-quarters house; while the summer head-quarters house has recently been condemned and will be rebuilt shortly. A rest-house costs about Rs. 3,000 inclusive of out-houses but with uncut timber free, and now consists of three main rooms and adjoining dressing rooms and bath-rooms and a front, side, and back verandah—a very great improvement on the old shanties which have done duty for so many years.

Rights.

The control of rights does not give rise to friction with zamindars. Annual grants of timber are made by the Divisional Forest Officer or authorised assistant, and trees are marked by the Forest Department. The levy of fees, payable to the Raja, since 1903, has approximately limited the timber asked for to the actual requirements, although the richer villagers ordinarily make demands for more timber than they require. When timber is sawn the fees are returned in full and the use of the saw for deodar timber is likely to become universal, a great advance on the customs of 35 years ago, when even in the most sophisticated range, the Pabar, Mr. Moir remarked that no single sawyer existed. Throughout the State the people do not now object to the control of the forests by

the Forest Department, chiefly because their liberties are so little restricted.

Forest offences are few and very rarely serious, owing to the full provision for the exercise of rights, helped by the possession of magisterial powers by the Divisional Forest Officer.

Fires.

Fires have practically ceased since the lease except in Chir (*Pinus longifolia*) forests where accidental fires account for some 300 acres annually. Below and above the forests are extensive grazing grounds sufficient, ordinarily, for the villagers' requirements. The Lower grazing grounds are burnt every winter, while snow lies in the forests, by the villagers under control of a Forest Guard, and thus serve the double purpose of an effective fire-trace and a more than adequate fodder reserve. In the Upper Ranges the lower slopes are very scantily covered with grass and, owing to the forests being particularly dry, firing is regarded as too dangerous. Fires have not occurred in recent years and the writer is of opinion that the reason lies in the sufficiency of the pastures, the general good behaviour of the villagers and their prompt help in extinguishing any fire at its inception. There is no doubt that the fact that the Divisional Forest Officer is also Political Assistant to the Superintendent, Hill States, Simla, helps matters considerably, as he is able to insist on observance of the few simple fire rules and on prompt attendance to put out forest fires.

The Pabar Valley.

A reference has been made to the Pabar blue pine and deodar forests for which a separate Plan on the regular regeneration method has been followed since the beginning of 1912. The Plan deals chiefly with extensive young blue pine woods that have sprung up under scattered mother trees since the lease and consequent stoppage of firing. These woods are likely to be of great value in the future and the amount of work connected with their management has enormously increased in the last few years. As an instance, regular thinnings alone have taken place in 2,700 acres of dense pole woods annually and have only been carried out with the help of Foresters specially trained at the Punjab Forest School and of two Head Guards

who luckily have learnt to thin young woods properly. Attempts to carry out the work with the ordinary Divisional staff were hopeless failures; but arrears have now practically been cleared off.

Establishment.

The Divisional staff shows a large increase, and whereas previous to 1890, one Forest Ranger, seven Foresters and seventeen Forest Guards were entertained, there are now two Probationary Extra-Assistant Conservators of Forests, seven Forest Rangers, two Deputy Rangers, eight Foresters, ninety Forest Guards, two Forest Treasurers and one Sub-Assistant Surgeon in addition to office establishment and subordinates on the temporary establishment. The work is more than one Deputy Conservator of Forests can control properly and this has recently been recognised by Government who have sanctioned proposals for splitting the Division. When the rough nature and extent of the country are also considered, it will be realised how very necessary this step is.

Extraction.

As already mentioned, log work has entirely given place to sleeper work in the last decade. Logs used to be cut to 10 and 12 feet lengths, were then *dragged to horizontal rolling roads and levered along until they* came to earthen slides down which they were shot. At intervals there were check walls and breastworks to check the impetus of the logs and in rocky portions of the slides wooden shoots were used. Areas were exploited which, to one who had not seen these rolling roads, would have seemed quite impossible to work in log. The roads ran above or below precipices, crossed streams by rough wooden bridges and in at least one instance led to the Sutlej after traversing some four miles of very bad ground.

In the Upper Ranges the country is thinly populated and local labour is insufficient, necessitating the import of hundreds of sawyers and carriage coolies. Food for these men is not obtainable locally and has to be imported from below at considerable cost and trouble.

In 1908, a lease was given to the Sutlej Forest Company on the condition that an attempt was made to erect ropeways for the transport of logs and a considerable monetary concession was

50 Years of Forest Administration in Bashahr.

Fig. 1.

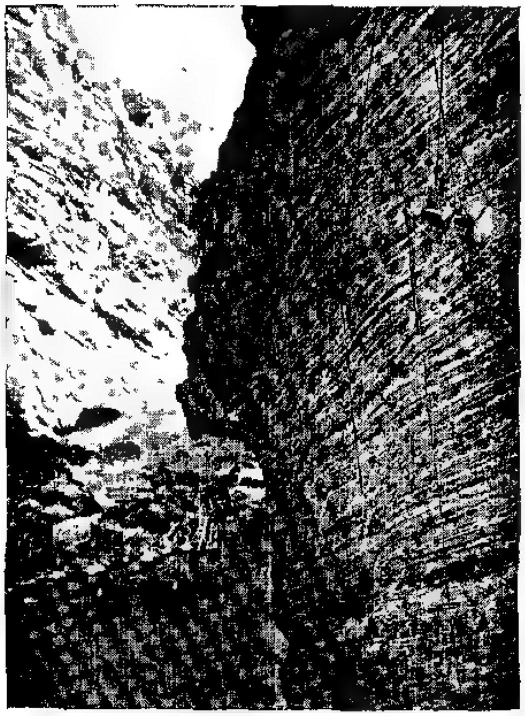


Fig. 2.

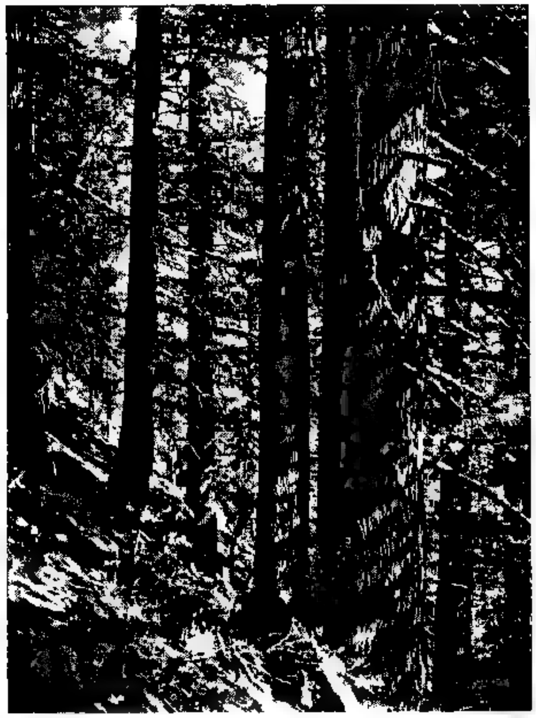
Fig. 3.

Photo Mech. & Litho. Dept., Thomason College, Roorkee.

ROAD-MAKING IN MAIN SUTLEJ VALLEY.

50 Years of Forest Administration in Bashahr.

Fig. 4.



VIRGIN DEODAR.

Fig. 5.

Fig. 6.

Photo.-Mechl & Litho Dept., Thomason College, Roorkee.

THE KATHOLU CATARACT AND RAPIDS.

offered if saw-mills were successfully introduced. Saw mills were not built and a ropeway for logs was not erected, but a simple wire ropeway was used for the carriage of scantlings. This ropeway is cheap and very effective, especially in precipitous country and has been patented by Mr. C. H. Donald. The country is generally too steep for the successful working of slides except for short distances, though wet slides have been erected in some of the worst floating nullahs, and telescopic slides are used in many places. Sleepers are for the most part launched direct into the Sutlej in which bad cataracts and rapids occur at Katholu below the main deodar areas. (Plate 13, figs. 5 and 6.) When the forests were worked departmentally, sleepers were only passed over this obstruction in August, but even then a certain percentage was smashed while damage at other times of the year is great. Attempts to blast the main channel have proved abortive and it will be necessary to construct a boom and a slide past these rapids before spruce and silver fir are worked in the Upper Ranges. Construction will be difficult as one bank consists of a vertical precipice and the other of loose boulders, but so many sleepers are broken at any time other than when the river is in flood that the attempt must be made. The lower reaches of the river present little difficulty and theft is not common.

Finance.

The accompanying schedule shows the financial results of the Division. The figures are complicated by the inclusion of sales in the Pabar and Depôt ranges in the last eleven years, but as these ranges did not yield a considerable revenue during the period their effect may be neglected :—

Year.	Annual revenue.	Annual expenditure.	Annual surplus.
	Rs.	Rs.	Rs.
1864-65 to 1879-1880	49,400	45,600	3,800
1882-83 to 1891-92 .	1,06,000	89,200	16,800

Year.	Annual revenue	Annual expenditure.	Annual surplus.
	Rs.	Rs.	Rs.
1892-93 to 1903-04	1,48,900	1,08,000	40,900
1904-05 to 1914-15 ..	2,79,500	1,76,200	1,03,300

[The anticipated surplus for 1915-16 amounts to two lakhs of rupees but includes about Rs. 60,100 of Pabar revenue.]

Thus we see a progressive rise has taken place since the lease commenced. In the last period an average contribution to the State of Rs. 20,300, over and above the annual lease money (Rs. 10,000), has been included, so if we add this to the surplus for the last period we have an average yearly surplus of Rs. 1,23,600. Large contributions to the Public Works Department for developing internal communications have also been made and debited to expenditure.

It will be remembered that the lease of these forests was undertaken solely to preserve the forests from rapid destruction and not to make a profit; also that the Working-Plans Officer in 1892 estimated that the Division would be run at a loss. When it is also remembered that previous to the lease "a bag of rupees" was sufficient to obtain a permit from the Raja for cutting an unlimited number of trees, a better perspective of the marked increase in the financial prosperity of the Division can be obtained. Large areas of blue pine, spruce and silver fir remain to be worked and, with the splitting of the Division, will be taken in hand and should give a largely increased revenue.

It would be out of place here to discuss in detail the loss involved in the comparatively recent change from departmental work to extraction of the outturn by traders, who have a lease extending till March 1923; it may be noted, however, that much better financial results in the last few years would undoubtedly have been obtained had the forests been worked departmentally.

The value of deodar timber in the plains has risen markedly in the last few years and it is more than doubtful whether the Forest Department is getting the full benefit that it ought from that rise.

The State has benefitted very considerably from the lease owing to the annual payment of the lease money, which the late Raja left almost intact for his successor; the annual contributions which the State has received for building schools, hospitals, etc.; the opening up of the country by roads and bridges; and last, but not least, the preservation and extension of forests which will in future yield not only sufficient timber for all local requirements but also a very handsome revenue, and which ensure a steady flow of money to the State in the shape of local payments for the extensive forest works.

KEY TO FOREST FLORA OF THE SOUTHERN CIRCLE, CENTRAL PROVINCES.

BY H. H HAINES, I.F.S

Artificial Key to the Trees, Shrubs, Climbers and Undershrubs.

PART IV. CLIMBERS (excluding small herbaceous climbers).

I. Leaves simple (O in Cuscuta and Cassytha; reduced to scales with clusters of acicular cladodes in Asparagus).

A. Leaves opposite.

§ Margins of leaves entire.

* Leaves penni-nerved (sub-palmi-nerved or sec. n. very close to base in 414, 415 and section ††).

† Juice milky.

(1) Leaves mostly under 4″, base not deeply cordate.

(*a*) Small subulate interpetiolar or intrapetiolar projecting glands present.

Branches pale. L. 1·5—3″ rarely 4·5″ usually glabrous, pellucid dotted, sec. n. 6—9. Fls m s. white ·5—·75″.	410	336	Vallaris.

Branches rusty. L. 2·5—4″, shortly acuminate, sec. n. 4—5. Fls. small white panicled.	411	339	Ichnocarpus.
Slender twiner, glabrous or with white pubescence. L. from linear to broadly elliptic 2—3″ pale beneath and sometimes with pale streak above, mucronate. Fls. very small purple, axillary.	412	340	Hemidesmus.
Large cultivated climber. L. 3—4″ oblong with over 12 fine spreading sec. n., glossy. Fls. over 2″.	413	344	Cryptostegia.

(*b*) Subulate or granular glands absent, or at base of leaf above.

Branches pubescent. L. dark green pubescent 1·5—2·5″ not mucronate. Petiole ·25—·5″.	414	347	Gymnema.
Branches and leaves pale, minutely pubescent or tomentose beneath. L. 1·5—3″ with usually straight base, sometimes palmi nerved. Petiole ·5—1·5″. Fls. ·25″.	415	352	Leptadenia

(2) Leaves mostly over 4″, not deeply cordate. Subulate axillary glands mostly present.

Strong climber. L. 4—5″ pale glaucous beneath, sec. n. very fine spreading over 20, united into an intramarginal nerve.	416	341	Cryptolepis.
Strong climber. Lower L. attaining 10″ ovate to oblong, upper often oblanceolate 3—6″. Sec. n. 12—15 strong.	417	338	Anodendron.

†† Juice not milky.

Stout, sub-scandent.	Branchlets appressed hairy. L. ovate to ovate-lanceolate 3·5—6″, 2-glandular at base (295).	418	79 Hiptage.
Large woody climber, shoots tomentose.	L. mostly oblong 3·5—4·5″ shortly suddenly acuminate, old glabrous except in nerve axils, eglandular, sec. n. 5—7.	419	266 Combretum decandrum.
Large woody climber, shoots tomentose.	L. broad elliptic to ovate, obtuse or obtusely cuspidate, pubescent or copiously dotted with minute gland scales beneath.	420	267 Combretum ovalifolium.
Large woody climber.	Shoots and leaves persistently brown hairy. L. ell. acuminate 3·5—5″ copiously covered with gland-scales beneath (235).	421	269 Calycopteris.
Woody rarely climbing.	L. long-acuminate, glabrescent, eglandular 3·5—5″, sec. n. 7—8, petiole ·3—1″ (296).	422	321 Jasminum arborescens.
Climbing.	Branchlets pubescent. L. lanceolate to ovate acute mucronate ·5—2″. Cor. tube ·5—·7″.	423	322 Jasminum angustifolium.
Climbing.	Pubescent or glabrous. L. ovate, sometimes cordate, obtuse, mucronate ·5—2″, some at least with two rudimentary or subsidiary leaflets (3-foliolate).	424	323 Jasminum auriculatum.

** Leaves distinctly palmi-nerved and deeply cordate (exc. some 425 and 428).

† Juice milky (sometimes sub-watery in 425 and 428).

(1) Leaves mostly under 4″. Glands present at base of leaf (exc. 426).

L. pale, often closely resembling No. 415 but quickly glabrescent between the nerves, 2—4″ ovate acute or acuminate. Petiole 1—1·75″. Fls. ·75—1″.	425	351	Telosma.
Slender. Hairy all over. L. 2—2·5″ cordate, ovate-caudate. Petiole slender 1—1·5″. Glands not seen.	426	345	Pergularia (Dæmia).
Dwarf. Stems pubescent. L. 1·5—3″ (mature 7) broadly oblong or ovate-oblong cordate, obtuse or cuspidate, pubescent on nerves.	427	348	Marsdenia Hamiltonii.

(2) Leaves mostly exceeding 4″. Glands at base of leaf (exc. 429).

Stems stout corky lenticellate. L. 4—6″ hoary with minute curled pubescence.	428	350	Marsdenia volubilis.
Stems stout (·5″ diam.). All parts densely velvety tomentose when young and pubescent in age. L. 4—7″ shortly finely acuminate, base deeply cordate with the lobes often incurved.	429	349	Marsdenia tenacissima.
L. 3—6″ ovate to ovate-oblong with deep basal sinus and incurved lobes, puberulous on	430	346	Holostemma Rheedii.

nerves beneath, shortly sharply cuspidate. Peti. ·75—2″.

†† Juice not milky. (See also Nos. 451—457 Dioscorea spp.).

L. orbicular deeply cordate suddenly acuminate 5·5—6″ densely appressed silky beneath. Fls. small white panicled. Frt. winged. 431 80 Aspidopterys.

§§ Margins of leaves not entire.

L. simple or ternate with large ovate acute lobes. Simple leaves 1—1·5″. 432 1 Clematis.

Hoary tomentose shrub. L. ovate coarsely toothed or crenate 4—8″, sub-palmi-nerved, gland dotted and rough with hair bases when old. Petiole ·5—·75″. 433 414 Symphorema.

Nearly glabrous twiner. L. 2—3″ with cordate or hastate base, toothed. 434 395 Thunbergia fragrans.

B. Leaves alternate or O (opposite in 456, opp. and alt. in other Dioscorea).

§ Margins of leaves entire.

* Leaves penni nerved (acicular in 437, rudimentary in 438 and 439.

† Branches with stipular prickles.

Shoots rusty. L. ell., to orbicular-obovate up to 2·5 often retuse. 435 15 Capparis horrida.

Branches grey. L. mostly under 1·5″ retuse. Fls. small white umbelled. 436 16 Capparis sepiaria.

†† Stems and branches with reflexed prickles. L. (cladodes) acicular. 437 502 Asparagus.

†††Branches unarmed. Stout thorns on the trunk in—

(1) Slender filiform leafless parasites feeding by suckers on other plants.

Light yellow green fleshy thread like stems. Fls. small 5-merous.	438	371	Cuscuta.
Dark green, scarcely fleshy, thread-like stems. Fls. very small 3-merous.	439	426	Cassytha.
(2) Slender climbing shrubs with tendrils. L. ovate or lanceolate 2·5″.	440	117	Helinus.
(3) Stout, sarmentose, scarcely climbing with opposite circinnate woody tendrils below the clusters of leaves.	441	77	Hugonia.

(4) Often climbing by the long branches but not twining and without tendrils (branchlets occasionally circinnate in 446). Leaves usually bi-farious.

(*a*) Leaves mostly under 4″. Sec. n. mostly weak.

Sarmentose. L. ·5 1·75 rarely with stipular spines.	442	442	Kirganelia.
L. mostly oblong and obtuse 2—3′, lower ovate, somewhat pubescent beneath, petiole ·2—·3″.	443	104	Olax scandens.
L. mostly lanceolate to ovate-lanceolate, acuminate, 1·5—3·5″ glabrous, minutely lineolate and (translucent) dotted. Peti. ·1—·15″. Bracts orbicular.	444	105	Opilia.
L. mostly lanceolate-ovate or ovate, acuminate, 2—4·5″, glabrescent but usually puberulous on nerves, dotted as in 444, bracts subulate.	445	106	Cansjera.

(*b*) Leaves mostly over 4". Sec. n. rather strong and raised beneath.

Branches green, often pubescent. L. glabrous 3—5·5", usually faintly crenulate, tertiary n. very fine numerous parallel.	446	111	Ventilago.
Branches brown-tomentose. L. 3—6", minutely dotted beneath and nerves brown-pubescent, tertiary n. reticulate.	447	365	Erycibe.

** Leaves palmi-nerved.

† Stems prickly, at least below.

(1) Stout climbers with stipular tendrils.

L. 5—7·5" elliptic or ell.-ovate, sheath of petiole winged and wing more or less auricled.	448	501	Smilax protifera.
L. 6—12" broadly elliptic or orbicular. Sheath stout but not winged nor auricled.	449	500	Smilax macrophylla.

(2) Twiners. Tendrils absent. Root not tuberous. Fls. showy.

Stems muricate. L. 2—4" cordate ovate glabrous acute.	450	370	Ipomæa muricata.

(3) Twiners with annual stems developing in the rainy season from large tubers. Fls. small greenish with six perianth lobes. Frt. 3-winged coriaceous.

Stems strong characterised by the hard often aculeate bases of the fallen petioles and prickly below. L. mostly alternate sub-orbicular to ovate, cordate with large basal sinus.	451	496	Dioscorea aculeata.
L. mostly opposite, lower cordate, upper not cordate (453).	452	498	Dioscorea oppositifolia.

†† Stems not prickly.

(1) As in † (3) above. L. mostly over 4″ except near inflorescence, cordate (exc. some 453).

L. mostly opposite, glabrous, pale green above, pale glaucous beneath, usually ovate-oblong (452).	453	498	Dioscorea oppositifolia.
Tubers and axillary bulbils elongate and clavate. L. opp. and alt. dull dark green above, glaucous beneath, ovate deeply cordate, cross nervules strong parallel, main nerves decurrent as ridges on the petiole.	454	497	Dioscorea belophylla.
Tubers and axillary bulbils round. L. suborbicular, not glaucous, with 7—11 primary nerves and strong parallel cross nervules. Sepals linear.	455	494	Dioscorea bulbifera.
L. all opposite, thin, hairy all over or on the nerves when old.	456	499	Dioscorea anguina.
L. opp. and alt., stems angled or winged. Cultivated Yam.	457	495	Dioscorea alata.

(2) L. under 4″. Fls. small greenish. Fruit of one or more drupels (Menispermaceæ).

Stem corky. Branches with fleshy aerial roots. L. ovate cordate glabrous 3—3·5″.	458	10	Tinospora.
Slender, grey villous. L. deltoid to ovate-oblong 2—3″.	459	11	Cocculus.
Slender, pubescent or glabrous. L. orbicular-reniform, often peltate, 1—3″.	460	12	Cissampelos.

(3) Twiners. L. cordate. Fls. showy (Convolvulaceæ).

Stems and leaves beneath white silky. L. orbicular cordate 2 -3·5". Fls. white.	461	366	Rivea.
Stems hairy. L. beautifully silvery silky beneath, hairy above, ovate cordate 3—5". Fls. purple.	462	367	Argyreia sericea.
Juice milky. Stems and leaves strigose. L. ovate up to 7". Fls. purple.	463	368	Lettsomia.
Stems 3—4 angled or winged. L. glabrous or pubescent 3—8" Fls. white.	464	369	Ipomæa Turpethum.

§§ Margins of leaves not entire.

* Leaves penni-nerved (sec. n. often near base in 465). Large woody climbers.

L. mostly obovate rounded with short acumination 2—4·5" crenate. Peti. ·3 ·7".	465	108	Celastrus.
L. mostly ovate or ell. tapering, 3·5 -5·5". Peti. ·05—·3" (446).	466	111	Ventilago.

** Leaves palmi-nerved.

(1) Armed with stipular prickles. Tendrils O. L. serrulate or serrate.

Large woody climber with thorny bases on the stems. L. 1—2·5". Frt. black.	467	114	Zizyphus Œnoplia.
Sarmentose or climbing. L. 2·5—6" elliptic. Frt. white.	468	116	Zizyphus rugosa.

(2) Small climber with stinging hairs. Tendrils O.

L. often lobed or pinnatifid, 1—4", serrate, acuminate.	469	460	Tragia.

(3) Woody rambling shrub, unarmed. Tendrils O.

Stem 3—4 angled below. L. oblong or ovate-oblong, stellately pubescent.	470	61	Grewia flavescens.

(4) Sub-herbaceous climbers with tendrils. L. mostly 3—7 angled or lobed (Ampelidaceæ).

(*a*) Stem perennial, attaining 3—6″ diam. with thick corky bark.

Towery leaves tomentose coarsely toothed, old 6—12″ repand denticulate.	471	119	Vitis repanda.

(*b*) Stems dying down annually to the perennial root, or fleshy.

Stem 4-winged, fleshy, constricted at the nodes. L. 1—2″.	472	118	Vitis quadrangularis.
Stems not, or obtusely, angled, rather fleshy. L. 2—6″ pubescent.	473	120	Vitis Linnæi.
New shoots glaucous. Stems round hollow. L. 4—8″ quite glabrous.	474	121	Vitis latifolia.
Stems and leaves persistently tomentose. L. 6—10″, deeply 3—5 lobed.	475	122	Vitis tomentosa.

II. Leaves simple but very deeply 2-lobed.

An immense climber with large palminerved leaves and tendrils.	476	231	Bauhinia Vahlii.

III. Leaves composed of three leaflets.

A. Leaves opposite.

Lflts. subequal mostly 3-lobed (432)	477	1	Clematis triloba.
Lower pair of leaflets much smaller than terminal, often reduced to mere auricles (424).	478	323	Jasminum auriculatum.

B. Leaves alternate.

§ Leaves digitately 3-foliolate.

* Weak sub-succulent climbers with tendrils. Lflts. crenate or dentate.

All parts covered, at least when young, with short pubescence.	479	123	Vitis trifolia.
Covered with glandular bristly hairs	480	124	Vitis setosa.

** Twiners from tuberous roots without tendrils, prickly below.

Lflts. 3, 5—8″ long more or less obovate, caudate acuminate.	481	492	Dioscorea dæmona.

Lflts. 3—5, 3 -5" long, obovate, acuminate or cuspidate.	482	493	Dioscorea pentaphylla.

§§ Leaves pinnately 3-foliolate, leaflets usually stipellate.

* Lflts. gland-dotted beneath. Stipellæ sometimes rudimentary.

Stems pubescent. Lflts. rhomboid acuminate, lower 4—6', upper small.	483	186	Cylista.
Slender. Stem hairy. Lflts. ell. to obovate ·6—2·25", pod grooved.	484	185	Atylosia.

** Lflts. not gland-dotted.

† Forest species.

(1) Very large woody climbers attaining 1 ft. and more in girth, exuding red juice when cut.

Twining from right to left. Trunk with consecutive rings of red bast. Leaflets 4—9" minutely silky beneath, smooth above. Fls. small, cream.	485	174	Spatholobus.
As in 485 but leaflets ultimately quite glabrous.	486	174	var. denudatus.
Twining left to right. Lflts. 12—18" subrugose and dull above nervules pubescent fls. large, red.	487	175	Butea superba.

(2) m.s. or slender climbers, stems not exuding red juice when blazed.

Large. Stems with concentric bast rings. (n) Branches sparsely hairy. Lflts. lanceolate ovate 3·5—6". Shortly yellow hairy beneath. Fls. purple. Pod with plaited faces.	488	171	Mucuna imbricata.

(n) This character requires confirmation.

Large. Stems	without concentric bast rings. (n) Bark stringy. Root large tuberous. Lflts. 6—10″ pale beneath with adpressed white hairs; short appressed hairs above. Fls. blue appearing when leafless. Pod slender-constricted very hairy.	489	177 Pueraria tuberosa.
Annual, slender.	Lflts. 3—5″, silky beneath. Fls. purple. Pod turgid, densely bristly.	490	170 Mucuna pruriens.
Large sub-herbaceous.	Lflts. (wild form) 2—3″. Sparsely appressed hairy beneath and on midrib above. Fls. rose. Pod smooth, fleshy.	491	178 Canavalia.

†† Cultivated species.

(1) Tall climbers, or extensively rambling near the ground.

Lflts. glabrous or with few	adpressed hairs, ell. or ell.-ovate 3—6″, stipellæ minute deciduous. Pod smooth with large seeds.	492	178 Canavalia.
Lflts. hairy	3—4″, deltoidly-ovate, stipellæ acuminate persistent, ·1—·25″. Stipules strongly nerved ·2″ inserted by their base (495).	493	179 Dolichos Lablab.
Lflts. glabrous except	on nerves 3—6″, ovate to ovate-lanceolate, often sub-hastate. Stipellæ prominent ·1″ not acumi-	494	180 Vigna Catjang.

(n) This character requires confirmation.

nate. Stipules ·3—·9″ inserted above their base (496).

(2) Dwarf climbers or sub-erect.

L. strongly-nerved. Fls. purple in long racemes (493).	495	179	Dolichos Lablab (var.).
L. finely nerved. Fls. purple capitate on long peduncles (494).	496	180	Vigna Catjang (var.).
Slender. Lflts. ovate thin 1—3·25″. Fls. 1—3 axillary. Pods 1—1·6″ curved with thin appressed hairs.	497	183	Dolichos biflorus.
Slender. Fls. yellow on the tumid nodes of axillary racemes. Pods slender glabrous or hairy. Lflts. entire in some species, lobed, or deeply cut in others.	498	184	Phaseolus Spp.
Stems sub-erect. Fls. yellow or reddish axillary, scarcely racemose, not on tumid nodes. Pods linear-oblong recurved densely pubescent and hairy.	499	182	Glycine hispida.

IV. Leaves composed of five or more leaflets, alternate.

A. Leaves digitate or pedate.

Stout woody perennial with digitate 5—7 foliolate leaves. Lflts. 2—6″ glabrous.	500	286	Heptapleurum.
Slender annual from tuberous root, prickly below (482).	501	493	Dioscorea pentaphylla.
Sub-fleshy climber with tendrils. Lflts. serrate, pedate.	502	125	Vitis auriculata.

B. Leaves pinnate.

§ Leaves paripinnate.

Slender elegant climber. Lflts. ·5—·6″. Seeds white or red with black eye.	503	169	Abrus.
Strong spinescent climber with palm-like leaves (407).	504	508	Calamus.

§§ Leaves imparipinnate (Leguminosæ).

Lflts. 7—9, strongly-nerved, silky beneath, obovate-oblong 3—8″, cuspidate.	505	156	Millettia auriculata.
Lflts. 11—15, nearly glabrous or brown silky on midrib, oblong-obovate, 2—4″, cuspidate.	506	155	Millettia racemosa.
Lflts. 7—13, light green, glabrescent, 1—3′, broadly-oblong, very obtuse and apiculate.	507	201	Dalbergia volubilis.
Lflts. 7—13, dark green, minutely brown, hairy beneath even when old, 1—3′, lanceolate to oblanceolate, shortly tapering to a blunt or retuse tip.	508	204	Derris scandens.

C. Leaves 2-pinnate (Leguminosæ).

§ Armed with prickles on the branches and often, on the leaf rachis.

* Fls. racemose, showy. Main nerve of lflts. not close to upper margin. Rachis eglandular.

Lflts. ·5—1″, ovate oblong. L. with large foliaceous stipules. Pod prickly (396).	509	205	Cæsalpinia Bonducella.
Lflts. ·5—1″, oblong. L. with small stipules. Pod oblong with sharp cusp (395).	510	208	Cæsalpinia sepiaria.
Lflts. ·25—·5, 7—10 prs., oblong. Pod short fleshy 1—2″ (394).	511	206	Cæsalpinia digyna.

** Fls. very small, in panicled globose heads. Main nerve of lflts. very oblique or close to upper edge.

Rachis with large gland near base and between upper pinnæ.

Lflts. ·3—·6″, 15—25 prs., oblong with unequal base. Pod fleshy 2—4″.	512	250	Acacia concinna.
Lflts. ·2—·3″, 30—45 prs., oblong, pubescent beneath. Pods dry brown.	513	249	Acacia cæsia.
Lflts. ·1—·25″, 20—40 prs., lineal, glabrous or nearly so. Pods dry purple.	514	248	Acacia pennata.

§§ Unarmed.

Immense woody climber. L. ending in a 2-fid tendril. Pods large woody.	515	234	Entada.

PART V.—UNDERSHRUBS.

Plants not usually over 4 ft. in height, somewhat woody at base only ; often with several stems from the root.

I. Leaves simple.

A. Leaves opposite.

§ Leaves with entire margins.

* Leaves penni-nerved.

† Leaves gland-dotted beneath and aromatic.

Includes various herbs and small undershrubs not noticed in the list.	Labiatæ.

†† Leaves not gland-dotted nor aromatic (but translucent marks due to cystoliths often present. Acanthaceæ exc. 526).

(1) Spinous.

Ditch or marsh plants with spinescent whorls of pretty purple flowers.	516	379	Asteracantha.
Undershrub with glabrous elliptic leaves and yellow lipped flowers.	517	383	Barleria Prionitis.

(2) Not spinous.

(*a*) Surface (usually upper) of old leaves *lineolate*, i.e., marked with minute lines or dashes usually translucent, consisting of elongate crystals of oxalate of lime (sometimes obscure in 522, 523 and 524 or appearing as dots only). Fls. 2-lipped (exc. 525).

L. small, surface hidden by white tomentum. Sepals beautifully reticulate.	518	384	Barleria reticulata.
L. 4—8″ strigose on nerves, ovate, acuminate, decurrent on the petiole. Fls. blue in one-sided dense spikes.	519	387	Barleria strigosa.
Erect or diffuse 1—3 ft. L. 2—5″ adpressed hairy, sub-acuminate both ends. Fls. rose 1·5″ clustered or shortly spicate.	520	386	Barleria cristata.
Erect 2—4 ft. L. 5—6″ glabrous, glaucous beneath, sub-acuminate. Fls. handsome rose 2″ axillary and in spikes 3—8″ long.	521	385	Barleria montana.
Erect, cultivated only. L. ell. acute both ends 6—10″. Fls. large white spicate.	522	394	Adhatoda.
Erect, slender 3—4 ft. L. acuminate, minutely hairy beneath, attaining 9″ below narrowed into petiole 1·5—2″ long. Fls. white in panicled clusters.	523	389	Rhinacanthus.
Erect 2—4 ft. L. acuminate both ends, often shallowly dentate 3—5″. Fls. small white rose-spotted in spikes with white green-veined bracts.	524	388	Justicia Betonica.
Erect 2—4 ft. L. glabrous, or nerves pubescent, 5—8″ with 6—8 strong sec. n., base decur-	525	381	Daedalacanthus.

rent on the petiole. Fls. purple, sub-regular in spikes with green-veined acuminate bracts.

(*b*) Leaf surface not lineolate. Fls. regular.

Small undershrub with racemes of greenish-yellow or white flowers and 4-winged fruits. 526 268 Combretum nanum

§§ Leaf margins not entire.

* Leaves penni-nerved.

† Leaves minutely gland-dotted beneath and aromatic.

Stems 3—5 ft. L. ovate coarsely toothed. Fls. small pale rose clustered in dense panicled cymes (310). 527 415 Pogostemon.

L. often ternate oblong or elliptic 3—6″. Fls. large blue or whitish (306). 528 411 Clerodendron serratum.

†† Leaves not glandular beneath.

Inflorescence very glandular. Fls. blue. L. sessile 6—10″ (311). 529 382 Strobilanthes.

Inflorescence not glandular. Bracts veined, fls. white. L. petioled 2—6″ (312). 530 380 Petalidium.

** Leaves palmi-nerved. See Nos. 314 and 315.

B. Leaves alternate.

§ Leaves with entire margins (sometimes crenate in 533, repand in 542).

* Leaves penni-nerved.

† Leaves with minute red glands beneath.

Stems 1—3 ft. with broad-lanceolate leaves 3—7″. Branches with shaggy angles. 531 189 Flemingia bracteata.

Stems 3—4 ft. with lanceolate leaves 2—6″. Branches angled, not shaggy (324). 532 188 Flemingia strobilifera.

†† Leaves not glandular beneath. Fls. regular.

Bright green. L. 1—3″ glabrous. Fls. yellow ·7—1″ diam.	533	76	Reinwardtia.
Branches sarmentose. L. 2—4″ mostly glabrous. Fls. white ·6″ diam. (340).	534	311	Plumbago.

††† Leaves not glandular beneath. Fls. papilionaceous.

(1) Fls. yellow. Pod inflated, not jointed.

Strict 3—5 ft. L. linear or oblong 1—3″	535	142	Crotalaria juncea.
Bushy 1—2 ft. L. oblanceolate ·7—1″. Inflorescence very glandular.	536	145	Crotalaria ramosissima.
Bushy 1—3 ft. L. oblanc.-oblong 1·5—3″ glabrous above, puberulous beneath. Racemes not glandular, bracts small.	537	144	Crotalaria retusa.
Sub-herbaceous 2—4 ft. L. 3—6″. Bracts large ovate.	538	143	Crotalaria sericea.
Sub-herbaceous 1—2 ft. L. 1—2″ linear or oblanceolate obtuse white-silky beneath. Fls. in slender racemes. Pod exserted.	539	146	Crotalaria albida.
Similar to 539 but more herbaceous. L. less white beneath. Pod included.	540	147	Crotalaria linifolia.

(2) Fls. pink purple or white. Pod flattened, jointed.

Sub-erect or trailing. L. oblong 3—6″ with adpressed grey hairs beneath.	541	168	Desmodium gangeticum.
Erect 3—6 ft. L. broad-ovate 3—6″	542	168	Desmodium latifolium

** Leaves palmi-nerved. Fls. large regular yellow.

Shrub 3—5 ft. with ovate leaves tomentose beneath.	543	48	Thespesia (var.).

§§ Leaf margins not entire.

* Leaves penni-nerved, serrulate.

Leaves oblanceolate, stipulate. Fls. 1—1·5′ diam. handsome yellow.	544	94	Ochna pumila.
Leaves obovate, exstipulate. Fls. 2·5—3′ diam. purplish.	545	274	Careya herbacea.

** Leaves palmi-nerved. Hairs stellate.

† Leaf margin simply serrulate to coarsely toothed, not angled or lobed (sub-lobed in some 550, 556).

(1) L. 1—3′. Fls. not exceeding ·25″ diam. (Sterculiaceæ).

Thinly stellate. L. oblong-ovate plaited. Fls. pink in heads.	546	57	Melochia.
Tomentose or villous. L. oblong to ovate, plaited. Fls. yellow clustered.	547	58	Waltheria.
Glabrous. L. ovate acuminate. Fls. purple, very small, cymose.	548	59	Buettneria.

(2) L. 1—3·5″. Fls. ·3—·5″ diam. straw coloured or yellow (Malvaceæ).

Branches strigose. L. 1·5—3′ ovate to oblong ovate obtuse.	549	22	Malvastrum.
Slender, erect or diffuse 1—3 ft. branches with scattered hairs. L. 1—3″ cordate ovate to broadly ovate acute or acuminate, hairs scattered. Peti. long.	550	23	Sida veronicæfolia.
Erect. As in 550 but covered with glandular (as well as stellate) hairs.	551	24	Sida glutinosa.
Erect 1—3 ft., tomentose all over. L. 1—3″ cordate ovate. Peti. long.	552	26	Sida cordifolia.
Erect or diffuse. L. 1—2·5″ rhomboid-lanceolate to rhomboid-obovate, cuneate base	553	27	Sida rhombifolia.

	usually slightly cordate on the petiole, pale beneath more or less stellate. Petiole under ·25″.			
Sub-erect.	L. ·7—1·5 much as in 553 with 1—3 spiny tubercles at base of petiole.	554	25	Sida spinosa.
Erect or inclined.	L. linear-lanceolate 1·5—3·5″. Petiole ·2″.	555	28	Sida acuta.

(3) L. 2—6″ diam., usually orbicular cordate. Fls. 1—1·5″ deep yellow (Malvaceæ).

Erect, slender.	Branches and leaves beneath thinly white tomentose. L. 2—3″.	556	34	Abutilon indicum.
Erect 4—6 ft.	densely villous. L. softly tomentose beneath, less so above 2·5—5″.	557	35	Abutilon muticum.
Erect, stout, 3—6 ft.	densely tomentose, glandular and hairy. L. 3—6″.	558	36	Abutilon graveolens.

(4) Flowers red or white 1″ diam. with 5—7 subulate bracteoles (Malvaceæ).

Stems 1—2 ft.	L. ovate or ovate-lanceolate strongly serrate, 1—3″ often with a gland on the midrib beneath.	559	37	Hibiscus hirtus.

†† Leaves distinctly angled or lobed at base of plant, or (560) unlobed. Fls. small yellow not exceeding ·75″ clustered, closing towards noon. Frt. covered with spines (Tiliaceæ).

L. orbicular,	white-tomentose beneath, 1—1·5″, usually not lobed but irregularly toothed.	560	71	Triumfetta rotundifolia.
Lower leaves 3	4·5″ with rounded base and 3 lobed top, upper ovate rhomboid or sub-orbicular.	561	70	Triumfetta rhomboidea.

Lower leaves usually lobed, median usually ovate or ovate-lanceolate 3—6" hairy, upper lanceolate. Fls. ·75" when expanded.	562	69	Triumfetta pilosa.

†† Leaves distinctly angled or lobed, at least some of them. Fls. white or pink, or if yellow, then over 1" diam. (Malvaceæ).

(1) L. small to m. s. 1·5 –3·5" deeply 3-lobed with lobes sometimes again lobed.

Or scarcely lobed. Fls. white ·5—·7' without bracteoles.	563	38	Hibiscus Solandra.

(2) L. 2—3·5" diam. Fls. 1" pink, without bracteoles. Frt. with short spines.

Leaves angled, not divided beyond the middle.	564	29	Urena lobata.
L. deeply divided into 5 oblong lobes	565	30	Urena sinuata.

(3) L. small, roundish or ovate, with several lobes. Fls. red with 8—12 linear bracteoles.

Glandular pubescent. L. shallowly lobed ·5 –2'. Carpels not winged.	566	33	Pavonia odorata.
Glandular pubescent. L. deeply lobed. Carpels winged.	567	33	Pavonia zeylanica.

(4) L. 2—3·5" orbicular, deeply 3—5-lobed. Fls. white to pink 1" bracteolate.

Stems 3—4 ft. usually with harsh hairs. Bracteoles 5—6 deciduous. Calyx spathaceous.	568	44	Hibiscus ficulneus.

(5) Lower leaves usually over 4" often deeply lobed. Fls. large usually yellow with purple centres bracteolate.

(*a*) Forest plants. Fls. yellow.

Tall 4—6 ft. Lower leaves 2—5", 5-angled or lobed, upper narrow tomentose. Fls. 1—1·5".	569	39	Hibiscus panduraeformis

Hirsute or bristly, lower leaves orbicular (sometimes not lobed) 4—6", crenate, upper usually sagittate. Fls. 3 4". Bracteoles 10—15 filiform.	570	45 Hibiscus cancellatus
As in 570 but margins serrate, bracteoles 10 setaceous.	571	47 Hibiscus rugosus.
Stems shortly pubescent. Lower leaves 4—5" with large acuminate lobes, dentate, pubescent and hairy. Frt. with reticulately veined wings.	572	40 Hibiscus vitifolius.
Branches with sparse hispid hairs. Lower leaves 5—8" diam. with sparse 3-fid hairs. Fls. 2·5—3". Capsule oblong with gland hairs.	573	44 Hibiscus tetraphyllus.
Stems 4—6 ft. nearly glabrous. L. up to 9—10" with three large acuminate entire lobes, glabrescent. Petioles up to 8". Fls. 3—4". Calyx truncate.	574	48 Thespesia Lampas.
(*b*) Cultivated plants. Flowers often white.		
Stem usually with scattered prickles, lower leaves sometimes not lobed. Fls. subsessile. Calyx with five large glands.	575	41 Hibiscus cannabinus.
Nearly glabrous. L. with gland on midrib. Bracteoles accrescent with calyx.	576	42 Hibiscus Sabdariffa.
(6) Creeping pubescent shrub with milky juice and variously lobed, rarely unlobed, toothed leaves 2—5" long.	577	476 Ficus heterophylla.

II. Leaves 3-foliolate, alternate (Papilionaceæ)

* L. with small red glands on under-surface.

Dwarf, 6—18″ from perennial woody stock. Lflts. large 5·5—7″. Peti. winged.	578	194	Flemingia nana.
Diffuse 1—2 ft. with brown tomentose angular branchlets. Lflts. 3·5″ lanceolate. Petiole not winged 1—2″.	579	195	Flemingia prostrata.

** Lflts. without glands. Sec. n. strong, Fls small, white or pink.

Simple leaves often present. Lflts. broad ell., or ell ovate, end one 2·5—4·5″ rounded both ends. Fls. in lax racemes, *with hairy pedicels ·1—·15″.*	580	162	Uraria hamosa.
Simple leaves rarely present. Lflts. much as in last. Fls. in dense racemes. Pedicels often ·4″ very densely hairy.	581	163	Uraria lagopus.
Branches grey hairy. Lflts. more ovate tapering to blunt apex, end one 3—4·5″. Fls. hidden in pairs of suborbicular veined bracts ·5″ diam.	582	165	Desmodium pulchellum.
Branches 3-cornered with shaggy hairs End lflt. 4—5·5″ acuminate. Fls. in dense umbellate clusters along the branches.	583	166	Desmodium Cephalotes.
Branches round with usually long hairs. Stipules persistent with long filamentous points.	584	167	Desmodium polycarpum

End lflt. obovate 2—2·5′. Fls. in close racemes 1—3″ long.

III. Leaves pinnate.

§ Leaves paripinnate.

Gregarious, herbaceous 1—2·5 ft. Lflts. 3 prs. obovate.	585	218	Cassia tora.
Often sub-gregarious 2—4 ft. Lflts. ovate 3—5 prs., 1·5—4″ long.	586	217	Cassia occidentalis.
Erect, 3—10 ft. with muricate branches. Lflts. 20—40 prs., ·5—·7″. Pod very long and slender.	587	159	Sesbania aculeata.

§§ Leaves imparipinnate (sometimes ending in a point in 588).

Habit of 586 but 3—6 ft. only, usually minutely muricate. L. 2 4″. Lflts. 41—81. Pod 1— 1·7″ jointed.	588	...	Aeschynomene indica.
Robust, soft wooded with large pith. L. 3—6″. Lflts. 61—101. Pod 2′.	589	160	Aeschynomene aspera.
Shrubby gregarious, 1·5—2·5 ft. Lflts. 9—19 oblanceolate obtuse or retuse ·75—1″.	590	154	Tephrosia purpurea.
Sub-herbaceous ·2—3 ft. Lflts. 3—7, linear-oblong, 2·5—4·5″, lower sometimes simple.	591	161	Uraria picta.
Herbaceous from perennial root. Lower leaves 1—2 very large ovate 1—2 ft. Upper very few pinnate with few leaflets.	592	126	Leea macrophylla.

A MONORAIL IN USE IN SIAM.

The following is the description of a monorail being used by Messrs. Leonowens, Ld., for the extraction of timber in Siam under one of their leases. This has been sent us by Mr. Medworth Deputy Conservator of Forests, Nakon Lampang, Siam :—

"The rails are 14 lbs. and take a maximum load of 6 tons up gradients of 1 in 12. The sleepers are iron (say 1 foot by 8 inches) and are attached to the rail by a simple process. They are also slightly concave to prevent sinking. The trucks are double bogie with roller and caster bearings and can negotiate a curve with a radius of 16 feet. The log is easily loaded as the trucks clear the ground by only a few inches. The length of line on which experiments were carried out was about one mile and first a 3 ton and then a 6 ton log was run over this four times daily for 3 or 4 months without any sign of wear and tear to the line or trucks, except a slight wearing of the rim of the wheel occasioned by an excessive use of the brakes. There was no sign of the sleepers sinking into the ground. Four buffaloes in good condition can negotiate a rise of 1 in 17 with a 6 ton load. It is not necessary to grade the road particularly as the single line may be laid even 'distortedly' without appreciably adversely affecting the running of the trucks. It is only necessary to clear and grade a small space for the line to be laid and another on the same plane at the proper distance away for the buffaloes to walk. Where there is sufficent timber to handle or where roads are unsuitable for ordinary carting, the use of the monorail should reduce the cost of working."

EDIBLE BIRDS' NESTS IN THE SOUTH TENASSERIM DIVISION, LOWER BURMA.

BY A. B. NIXON, I.F.S.

Since Edible Birds' nests have been included under Minor Forest Produce in 1909, the right to collect them in the South Tenasserim Division has been sold by auction for three years' periods.

There are two groups of islands where these nests are found. One, the Mali group, is on the northern fringe of the Mergui Archipelago islands, and about 60 miles north-west of Mergui; the other, the Ye-E group of islands is some 100 miles down the coast below Mergui. In the Mali group there are four islands or rather limestone rocks where the nests are found. It is impossible except for professional climbers to land on any of them, as they rise precipitously from deep water. The largest rock covers perhaps 100 acres and rises to about 500 feet at its highest point. Round the whole circumference of the islands from high water mark, the rock has been eaten away by the action of the sea, which at low water exposes a continuous overhanging arch of rock, sometimes 20 feet wide. The surface of the islands is nearly bare rock, much contorted, jagged and fissured, with many caves having small entrances and widening out into larger caverns inside. Those between high and low tide mark can be entered by small boats. It is in these caves, 90 in number on the largest island, where the nests are found.

The birds, of which there are two varieties, appear on the islands about December and have completed building their nests by March. The collection of nests takes place in March and April, and such young birds as are overlooked or spared hatch out about May. By the end of June all the birds have migrated, flying vertically to an enormous height and then in a direction which has not yet been determined.

The collection of nests is done by 12 professional climbers—two men climb to the top of a precipice and one lets down the other at the end of a rope on a 'saing' or sort of basket with a cane bottom and four supporting ropes.

This basket is directed by the man above to the required caves when the man from the basket enters with a light and collects the nests with the aid of a stick.

There are two varieties of nests, white and black, corresponding to the two varieties of birds. The nests rather resemble oblong shallow shells in shape, standing out horizontally from the rock. Though they vary considerably in size, the white ones are usually

$2\frac{1}{2}$ inches long and $1\frac{1}{2}$ inches broad and the black ones of half an inch larger dimensions. The white ones have no feathers bound up in them, while the black ones all have feathers mixed up in the substance of the nest. The white nests which are used for eating are the valuable ones and are very much rarer than the black ones which are of little value.

For consumption, the dish is prepared by soaking in water and sweetening slightly, when it is drunk as a soup. Personally, I found the dish to be practically tasteless.

The market is chiefly in Penang, where, before the present war, the white nests were sold through brokers at Rs. 150 to Rs. 160 per viss (3·60 lbs.). Small quantities are also exported to Rangoon. The monopolist pays Rs. 25 per viss (3·60 lbs.) on contract for collection *in situ*.

Black nests only fetch Rs. 3 per viss (3·60 lbs.) in Penangpur Re. 1 per viss (3·60 lbs.) is paid by the monopolist for collection *in situ*, while the total extraction charges for both nests together, including landing in Mergui port by country boat, are Rs. 50 per viss. The black nests find their way largely to Shanghai, where, it is said, by a process which includes pounding them up and mixing them with a chinese oil called 'Tung-ya,' the black colour is removed and the mixture is re-fashioned into imitation white nests worth Rs. 25 a viss. These only remain good 4 or 5 days.

A serious problem has now arisen owing to the presence within the last few years of a predaceous bird called 'gyo-thein,' probably a kind of hawk, which attacks the small birds. Years ago, all the local people affirm that there was no tree growth whatever on the islands and the 'gyo thein' was unknown. But within the last 12 or 15 years small trees and shrubs have appeared here and there along crevices, the seeds of which have been brought presumably by birds. The hawks now live and breed on the islands, nesting in the vegetation and preying on the small birds, to such an extent that now the quantity of Edible Birds nests available for export has been considerably reduced. Whether it is true or not that the islands were formerly totally destitute of vegetation is not certain, it is however perfectly true that vegetation

has been increasing yearly of late and that with the number of the hawks which nest in this vegetation has also increased.

In order to prevent this unusual form of forest produce from becoming much reduced, the only feasible remedy appears to be to cut down every scrap of vegetation on the islands, which, though scanty, will be a slow and laborious process, as rope-climbing must be resorted to, to fell each little tree and shrub. It is interesting to note that the present monopolist is willing to do this conditionally at his own expense.

BOMBAY FOREST CONFERENCE.

[*We print below three papers presented by Forest Officers at the last Bombay Presidency Forest Conference.*]

I.

THINNINGS OF TEAK COPPICE IN THE POLE AREAS OF KANARA.

In order to find out whether the thinning out of the inferior coppice shoots of teak on each stool stimulates the growth of the remaining shoots, experimental thinnings were made in four sample plots of various ages in Kanara. In each plot all the shoots on half of the stools were left standing and the better shoots on each stool measured. The shoots on the other half of the stools were thinned and only the best shoots left standing and measured. The thinnings were carried out in 1911 and 1912, and the measurements have been taken each year since.

Plot No. 1—Mundgod Coupe 1 of Block VI, felled in 1908. On 50 stools 162 shoots were thinned out and 91 left standing at three years after felling. On other 50 stools 139 inferior and suppressed shoots were left standing but not measured, and 164 better shoots were measured. The results of measurements are shown below :—

Age of shoots.	HEIGHT IN FEET.		GIRTH IN INCHES.	
	Thinned	Unthinned	Thinned.	Unthinned.
3 years	12·67	12·26	5·34	4·96
6 ,, ...	19·00	18·82	8·74	8·11
Increment in three years	6·33	6·56	3·40	3·15

Plot No. 2—Katur Coupe 45 of Block XI, felled in 1905. On 40 stools 104 shoots were thinned out and 52 left standing at seven years after fel.ing. On 40 other stools 70 shoots were

measured and 84 suppressed or inferior shoots were left standing but were not measured. The results of the measurements are shown below :—

Age of shoots.	Height in feet.		Girth in inches.	
	Thinned.	Unthinned.	Thinned.	Unthinned.
7 years ...	18·90	18·36	9·79	9·53
9 ,, ...	21·00	20·33	11·44	10·77
Increment in two years ...	2·10	1·97	1·65	1·24

Plot No. 3—Haliyal Coupe 2 of Block I at Mundki, felled in 1901-02. Here only the girths have been measured, and there is no information as to the number of shoots removed in the thinning. On 20 thinned stools 47 shoots have been measured, and on 20 unthinned stools 54 shoots have been measured. The thinned shoots have grown in girth from 13·5 inches at 9 years to 16·8 at 13 years, and the unthinned shoots from 11·4 inches to 14·5 inches. Thus in four years the thinned shoots show a girth increment of 3·3 inches and the unthinned shoots a girth increment of 3·1 inches.

Plot No. 4—Haliyal Coupe 6 of Block VIII at Mavinkop, felled in 1895-96. On 21 thinned stools 36 shoots have been measured, and 44 shoots on 21 unthinnned stools. The thinned shoots have grown in girth from 14·8 inches at 15 years to 16·6 inches at 19 years, and the unthinned shoots from 14·3 inches to 15·7 inches. Thus in four years the thinned shoots show a girth increment of 1·8 inches, and the unthinned shoots a girth increment of 1·4 inches.

Taking all the available figures for all the plots together it is found that the average annual height increment for thinned shoots is 1·82 feet and for unthinned shoots 1·92 feet, whilst the annual girth increment for thinned shoots is 0·87 inch and for unthinned shoots 0·81. The volume increment of each thinned

shoot would thus be somewhat greater than that of each unthinned shoot, but this would be more than made good by the greater number of shoots on the unthinned stools. On the whole, therefore, it may be said that the rate of growth of teak coppice does not seem to be much affected by thinnings. It might have been expected when half of the shoots on a stool have been thinned out that the remaining half would put on a greater amount of growth: but as a matter of fact fresh shoots are put out in place of those cut, and this continues year after year, at least in the case of young coppice such as that measured. Thinnings of teak coppice are probably advisable in order to allow the remaining shoots to develop properly; but none should be undertaken until the coppice is at least ten years old. Up till that age the shoots should all be preserved, in order to provide as much ground cover as possible.

A. G. EDIE,
Divisional Forest Officer,
E. D. Kanara.

II.

METHOD OF MEASURING TIMBER

For material removed from coupes sold standing, from Malki and Inam numbers and from Forest Depôts where actual measurements are not ordered to be taken, the tables of Classification and Calculation given on pages 166 to 170 of the Standing Orders (Forests) are useful and may continue to be in force.

2. The question is what tables would be suitable for taking actual measurements of timber in Sale Depôts. Carter's tables are prescribed for this purpose on page 170 of the said Standing Orders, while Mangesh Rangappa's tables are in use.

3. *Differences* between the two are as follows :—

Carter's tables.	*Mangesh Rangappa's tables.*
1. Length—From 10 to 50 feet in whole figures.	From 1 to 30¾ feet in fractions.

2. Girth—Whole girth in feet, from 1 to 12 feet.	Quarter-girth in inches, from 1 to 25 inches (*i.e.*, ⅓ foot to 8⅓ feet whole girth).
3. Cubic contents—One figure of decimal of a cubic foot in round.	Two figures of decimal of a cubic foot actual.

4. *Explanation*—

Item 1.—Carter's tables give measurements of logs 10 to 50 feet in *whole* length and prescribe 'sectional area' for finding out measurements of logs of any length.

Mangesh Rangappa's tables give measurements of logs 1 to 30¾ feet in *fractional* length.

Item 2.—Carter's tables give measurements of logs 3 to 36 inches quarter-girth equal to 1 to 12 feet whole girth and prescribe the 'sectional area' for finding out measurements of logs of 1 inch to 20 feet whole girth.

Mangesh Rangappa's tables give measurements of logs 1 to 25 inches quarter-girth equal to ⅓ to 8⅓ feet whole girth.

Item 3. *Example.*—A log 10 feet long and 50 inches in whole girth measures 10·9 cubic feet in Carter's tables and 10·85 in Mangesh Rangappa's tables.

5. *Remarks*—

Item 1.—Carter's tables leave much to be worked out and are useful for preparing a Ready Reckoner to the extent mentioned. Whereas what is required for subordinates in Depôts is a 'Ready Reckoner' in the true sense of the word, Mangesh Rangappa's tables serve this practical purpose but only up to 31 feet in length. The maximum length of logs brought to above-ghat Depôts is generally 31 feet. However to serve cases where longer logs are occasionally brought to Coast Timber Depôts, a supplement to Mangesh Rangappa's tables showing measurements of logs 31 to 50 feet in fractional lengths may be prepared.

Carter suggests that the contents of very long logs can be obtained by a simple arithmetical process, and cites an example that a log 67′ long has the same contents as the two logs, one 50′ and the other 17′ long of the same girth. This may be correct in theory but not in practice; because of the rule of calculating the length to the nearest ¼ foot: fraction below 1½″ being dropped and over 1½ reckoned as ¼ foot. Supposing the 50′ log actually measures 50′ 1½″ and the 17′ log 17′ 1¼″, the two as a whole would measure 67¼′, or if the 50′ log actually is 49′ 10⅝ and the 17′ log 16′ 11¼″ the two as a whole would be 66¾′ in length.

Item 2.—Since in Sale Depôts everything is actually measured, it is necessary that the tables should give measurements from the minimum girth. Mangesh Rangappa's tables give these.

Also occasionally logs of larger girth than 8⅓ feet (*i.e.*, 25″ quarter-girth) given in Mangesh Rangappa's tables are received. Carter's tables give them up to 12′ which may be a maximum, but only of *whole lengths* (*vide* Item 1) So a supplement to Mangesh Rangappa's tables showing measurements of logs from 8⅓ to 12 feet whole girth may be prepared.

Further, in the heading the whole girths in *inches* should be shown, as the calculation is made in inches: ½ and under of an inch is dropped and over half is taken as whole.

Item 3.—As every decimal counts in the total of a large number of logs, it is necessary with a view to ensure accuracy that two figures of decimal should be taken and Mangesh Rangappa's tables supply them.

6. *Measurements of Round and Squared logs*—

In Carter's tables the heading is given of Round logs. In Mangesh Rangappa's tables no such heading is given.

While actually the measurements given in both the tables are of Squared logs.

Example.—A log 10′ long 48″ in whole girth measures 10·00 cubic feet in both the tables, whereas a round log of the above dimensions actually measures :—

$$\text{Length} \times r^2 \times \pi = 10 \times \left(48 \times \tfrac{7}{22} \times \tfrac{1}{2}\right)^2 \times \tfrac{22}{7}$$

$$= 10 \times \tfrac{7}{11} \times \tfrac{7}{11} \times \tfrac{22}{7} = \frac{10780}{847} = 12{\cdot}71 \text{ cubic feet.}$$

Thus the difference, or actual loss is 2·71 c.ft. It is necessary therefore to have a separate set of tables for Round logs. It would be advisable to show them side by side with those of Squared logs, *vide* sample page A attached.

7. *Measurements of scantlings and sawn timber.*—It is desirable there should be a Ready Reckoner also for such material especially in Saw Mills. A page showing examples of the Calculations is appended, marked B.

8. *Conclusion.*—As suggested in paras. 1, 5 (items 1 and 2), 7 and 8, we should have one consolidated set of tables showing, firstly, the classification and calculation of standing timber mentioned in para. 1, secondly, the measurements together of Round and Squared logs of 1 to 50 feet in length and ¼ to 12 feet in girth, to two places of decimal, those of Round logs being shown in *italics* to distinguish the same at a glance from those of Squared logs and, thirdly, the measurements of scantlings separately.

9. *General Rules for taking measurements of logs*—

Length—should be taken to the nearest ¼ foot : fraction below 1½ inches being dropped and over 1½ inches reckoned as ¼ foot.

Girth—should be taken of all Squared logs at centre and of all Round logs at butt end where the 4′ 6″ height would be likely to come to the nearest inch : ½ and under being dropped and over ½ reckoned as 1 inch.

Moss, bark, cowdung, mud, etc., upon the log likely to vitiate its measurements should be removed. $(\text{Quarter-girth})^2 \times \text{length} =$ cubic contents

10. As regards the proposals contained in the correspondence beginning with Mr. Bijur's No. 111, dated 31st August 1914 and ending with Conservator of Forests, C. C.'s No. 1238, dated 29th June 1915, about (1) the corrigenda to the table for calculating

the cubic feet of timber given on pages 167 to 170 of the Standing Orders (Forests) and (2) the printing of a set of tables showing the measurements of logs 6—9 feet in length and 48—100 inches in girth as a supplement to Carter's tables :

(1) The corrigenda should of course be issued.

(2) Such measurements are already found in Mangesh Rangappa's tables and need no fresh introduction.

T. R. BELL,
Conservator of Forests, S. C.

SAMPLE PAGE—A.

Measurement of logs, Square and Round.

GIRTH 24 INCHES.

Length in feet.	Cubic contents of logs.		Length in feet	Cubic contents of logs.		and so on.
	Square.	Round.		Square.	Round.	
1	0·25	0·30	6¼	1·56	1·87	
1¼	0·31	0·37	6½	1·63	1·96	
1½	0·38	0·46	6¾	1·69	2·03	
1¾	0·44	0·53	7	1·75	2·10	
2	0·50	0·60	7¼	1·81	2·17	
2¼	0·56	0·67	7½	1·88	2·26	
2½	0·63	0·76	7¾	1·94	2·33	
2¾	0·69	0·83	8	2·00	2·40	
3	0·75	0·90	8¼	2·06	2·47	
3¼	0·81	0·97	8½	2·13	2·56	
3½	0·88	1·06	8¾	2·19	2·63	
3¾	0·94	1·13	9	2·25	2·70	
4	1·00	1·20	9¼	2·31	2·77	
4¼	1·06	1·27	9½	2·38	2·86	
4½	1·13	1·36	9¾	2·44	2·93	
4¾	1·19	1·43	10	2·50	3·00	
5	1·25	1·50	10¼	2·56	3·07	
5¼	1·31	1·57	10½	2·63	3·16	
5½	1·38	1·66	10¾	2·69	3·23	
5¾	1·44	1·73	11	2·75	3·30	
6	1·50	1·80	and so on			

SAMPLE PAGE—B.

Ready Reckoner of Sawn Timber per foot run contents in cubic feet.

Thickness of height in inches.	Breadth in inches.							
	¼	½	¾	1	1¼	1½	1¾	2	and so on up to 15.
1	·0017	0035	·0052	·0069	·0087	·0104	·0121	·0139	
1¼	·0023	0043	·0065	·0087	0108	·0130	0152	0174	
1½	·0026	0052	·0078	·0104	·0130	·0156	·0182	·0208	
1¾	·0030	·0061	·0091	·0121	0152	·0182	0213	·0243	
2	·0035	·0069	·0104	·0139	0174	·0208	·0243	·0278	
2¼	·0039	·0078	·0117	·0156	0195	·0234	0273	0312	
2½	0043	0087	0130	·0174	0217	·0260	·0304	·0347	
2¾	·0048	·0095	·0143	·0191	0239	0286	·0334	0382	
3	·0052	·0104	·0156	·0209	·0261	·0312	·0365	0417	
3¼	·0056	·0113	·0169	·0226	0282	·0339	·0395	0451	
3½	·0061	·0122	·0183	·0243	·0304	·0365	·0425	0486	
3¾	·0065	·0130	·0196	·0261	0326	·0391	·0456	0521	
4	·0069	·0139	0201	·0278	·0348	·0417	·0486	0556	
4¼	·0074	·0148	·0221	·0295	0369	·0443	·0516	·0590	
4½	0078	·0156	·0234	·0312	·0391	0469	·0547	0625	
4¾	·0082	·0166	·0247	·0330	·0413	·0495	·0577	0660	
5	·0087	·0174	·0260	·0347	·0434	·0521	·0608	·0694	
5¼	·0091	·0182	·0273	·0365	·0456	0547	0638	·0729	
5½	·0095	·0191	0286	·0382	·0478	·0573	·0669	·0764	
5¾	·0100	·0200	·0299	0399	·0499	·0599	0699	·0799	
6	·0104	·0208	·0312	0417	·0521	·0625	·0730	·0833	
6¼	·0109	·0217	·0325	0434	·0543	·0651	0760	·0868	
6½	·0113	·0226	·0339	0451	·0564	·0677	·0790	·0903	
6¾	·0117	·0234	·0352	·0469	0586	·0703	0820	·0938	
7	·0122	·0243	·0365	·0486	·0608	·0729	0850	·0972	
7¼	0126	·0252	·0376	·0503	·0629	·0755	0881	1001	
7½	·0130	·0260	0391	·0521	·0651	·0781	·0912	·1042	
7¾	·0135	·0269	·0404	·0538	·0673	·0807	0942	·1077	
8	·0139	·0278	·0417	·0556	·0694	·0833	·0972	·1111	
and so on up to 18.									

III.

REBOISEMENT OF BLANKS IN FORESTS.

Though from the title of the paper, it would appear to be one of a general nature, I wish to confine myself chiefly to the circumstances of the Deccan; the conclusions arrived at may, however, hold good for other parts of the Bombay Presidency where the forests are more or less poor.

2. Wood for building purposes and fuel is steadily becoming dearer and dearer in the Deccan, as the quantity produced in the country is insufficient to meet the increasing demand. Insufficiency of wood for building purposes is, to a certain extent, made up by the annual import of a large quantity of timber from Kanara, Thana and Burma; the supply of firewood has become a serious problem hard to meet and fuel is rising in price beyond the means even of some of the middle classes of people. In the Deccan villages, and to some extent in cities like Poona, a large quantity of cow-dung cakes annually goes to make up the quantity of fuel required; whereas all the available cowdung must have gone, in the shape of manure, to enrich the soil. The consequence is that owing to the insufficiency of manure the soil is rendered poor and less productive. Supply of firewood, in sufficient quantities, would greatly minimise the sale of cowdung cakes for fuel; and would thus enable the Rayat to supply manure to the soil in larger quantities than now, to the great advantage of the country. The solution of the difficulty of the supply of firewood lies in a great measure in the reboisement of blanks in the forests.

3. Reboisement of blanks in the Deccan forests is a vast subject which has been engaging the attention of Government and number of Forest Officers under them for years past; and so far no final conclusions seem to have been arrived at, as to the best method of attaining the object; the configuration, soil, rainfall, habits of people living in the neighbourhood of forests and such other factors being vastly different in different localities. The subject may, therefore, be said to be in an experimental stage still, to some extent.

Classes of Forests.

Forests in charge of the Forest Department in the Deccan, as at present constituted, may be roughly classed as follows for the purposes of this paper: –

(*a*) The hill forests, greater area of which is, at present, poorly covered and which might take centuries to be satisfactorily covered up, so as to be able to provide a sustained and sufficient quantity of wood, for fuel and timber, to the country all round.

(*b*) Flat lands which were mostly under cultivation till the great famine of 1876-77 but were then relinquished by their holders and thus reverted to Government and were afforested without any tree-growth to speak of, on them.

(*c*) Riverain babul forests.

Methods of Reboisement.

(*a*) The method of covering up lands of class (*b*) referred to above has been fully described by Mr. Osmaston in his interesting paper published in the *Indian Forester*, XXXIII, No. 6 of 1907, pages 265 to 273. The splendid plantations, principally of Nimb (*Melia Azadirachta*) situated at Ankai and Sawargaon, in the Yeola Range of the Nasik District, are the results of the experiments, carried on by him, of agri-*cum*-Forestry. Such areas now in the charge of the Forest Department are limited. The process of regeneration in such areas may be continued in the above manner with advantage; where it may not be possible, for any reason, other methods described later in the paper will have to be resorted to.

(*b*) The method of filling in the forests of class (*c*) is settled. This method, almost always, is of ploughing the land during the fair season after there has been a clear felling and sowing babul seed therein when rains set in; the resultant crop of seedlings is generally sufficient to fill in the area. Babul seed collected from the droppings of sheep and goats fed on babul pods seem to give better results than seed collected directly from babul pods in such plantations. It has been found by experience that in areas where sheep and goats, fed on babul pods, were made to rest at nights, the regeneration of babul is much more plentiful and healthy than in areas regenerated by sowing seed collected from pods and sowed in ploughed strips as stated above.

(c) The bulk of forest lands in charge of the Forest Department consists of forests of (a) class. Some of them are bare hill slopes and those that are clad also contain blanks in them. Some of these covered areas are teak bearing, some contain Anjan and some only Raiwal species.

Experiments for reboisement of blanks in forests have always been carried on in the past so many years; and the object of this paper is to place the experience, gained by the different methods, tried principally in hill forests, in the past for that purpose, before a body of responsible Forest Officers and after a full discussion of the subject to arrive at a conclusion as to the best methods, that could be adopted in the future, in the different types of forests. A considerable area of these hill forests seems to have been under Dalhi cultivation for a long time in the past, till such cultivation in the forest was stopped by the executive orders of the British Government. Enquiry with the old villagers leads one to think that most of the 'dalhied' hil. areas, when first taken up by Government, were either blank or thinly covered and that tree-growth in fairly large quantities has since sprung up on them. The present wooded condition of such hill forests in charge of the Forest Department is most favourably compared by such people with their condition that was, when they were under Dalhi cultivation, and gives hope of even a better future for the Deccan hill forests. The improvement already arrived at is due principally to the working of nature, rendered possible by strict conservancy. Experiments have been carried on, as stated above, from time to time, to see how nature could be helped by man in covering up blanks in these forests denuded of tree-growth chiefly by unrestrained practice of Dalhi cultivation during the pre-British times, sooner than they would be if left to themselves.

Methods adopted to help artificial regeneration in forest blanks.

The following are some of the principal methods tried to ensure artificial regeneration in blanks of hill forests:—

(i) Broadcast sowing of tree-seed.

(ii) *Dibbling of seed* under shelter of bushes.

(iii) Sowing of seed in pits, patches and raised mounds or strips.

(iv) Transplanting of seedlings from nurseries.

(v) Agri-*cum*-Forestry.

(i) Broadcast sowing does not seem to have been productive of any good results except perhaps when a few seeds out of a large quantity by chance got fixed in favourable places and gave seedlings, few and far between. The cause of this seems to be that the soil is too much hardened owing to heavy grazing, excessive exposure to the sun and want of humus. Owing to these circumstances the broadcasted seed generally got washed out of the forest by rain-water which runs down in great force for want of any impediment. This method, therefore, cannot be depended upon at all to gain the object. Want of new seedling growth in some of the thinly stocked hill forests, where broadcast sowing has often been tried, is a great proof against broadcast sowing.

(ii) Dibbling of seed has been productive of some good when done with proper care under shelter of bushes, showing thereby that the soil underneath them is better suited for the purpose of regeneration than that in the open. The shade offered by the bushes also helps to keep up the tender seedlings in the hot weather and the bushes themselves protect them against damage by animals to some extent. But there are forests where even bushes are wanting and dibbling of tree-seed in such places has given very poor results indeed. Therefore where there is paucity even of bushes, it seems worth while to create them. These when raised, it is thought, improve the soil under them and render dibbling tree-seed with success, under their shelter, possible.

(iii) What is called sowing in patches is being tried on a pretty extensive scale. Under this method pits are

made in the ground of dimensions varying from 1 foot to 3 feet square and 6 inches to 12 inches deep and refilled with good loose earth up to the surface of the ground and seed is sown in them at the commencement of rains. This method is found to be giving fairly good results provided the soil is good and deep and is not exposed to the sun throughout the day. The larger the pit the greater seems the chance for the seedlings raised in it, of surviving, in the hot weather, because the moisture absorbed by the soil in the pit is proportionate to the volume of the loosened earth in the pit and therefore to the dimensions of the latter. This method seems suited in regions of moderate rainfall, where wholesale opening of the soil is either impossible or prejudicial to the interests of the forests. Sowing in small pits about 6" deep has also been tried in some places without much success. In regions of heavy rainfall, like the forests round about Lonawla or Rajur, this method seems unsuitable because the moisture absorbed in the soil together with the water accumulating in the pits, exceeding the requirements of the tiny seedlings, they rot away. In such localities sowing in raised mounds or strips seems more suited than sowing in pits, as can be proved by results achieved in the Akola Range of the Nagar District in the last 2 3 years. In a few places (in localities of moderate rainfall), where the soil and the configuration of the land permitted, pretty large patches of land with thoroughly opened soil were substituted for pits refilled with earth for sowing seed and have given satisfactory results. This last method seems to be a compromise between sowing in pits and agri-*cum*-Forestry.

(iv) Transplanting of seedlings raised in nurseries maintained by the Department had been tried in the

Deccan on an extensive scale some years ago. It seems it had to be abandoned as the result obtained was not encouraging. The poor results were probably due to the fact that the seedlings, suddenly transplanted to places whereof the soil, climate, rainfall, etc., were totally different from those of their birth place and also to the fact that the conditions under which they were raised in the nursery were totally different from those obtaining in forest. In Deccan, often the rainfall, after the season of transplanting, is not sufficient to enable the seedlings to establish themselves well against the following dry season. Seedlings raised in small local nurseries and carefully transplanted at the proper time into forests situated within a few miles from them, continue to give some good results, other conditions being favourable. Seedlings, raised in the nurseries of Hiwra forest garden in Junnar Range of Poona Division and Akshi in Alibag Range of Kolaba Division, are every year transplanted into the forests in the neighbourhood and a fair percentage of them is found to survive. This much, however, can be said that a larger percentage of seedlings transplanted from nurseries die owing to a variety of causes than seedlings raised in the forests themselves, on the spot, where they are eventually to grow into trees. Seedlings from raised beds of nursery seem to stand transplantation better than those raised in the low beds.

(v) Agri-*cum*-Forestry successfully tried by Mr. Osmaston in the flat forests of Nasik District is recently introduced in some hill forests of the Central Circle slightly modified to suit the hilly tracts and the species of trees to be raised therein. It has given fairly satisfactory results without expense to Government; except in experimental plantations like that

of Satpur in Nasik. This method consists of cultivating the forest land for cereal crops and of raising tree seedlings side by side in it. In the Poona Division it was introduced some four years ago in the Junnar Range in the blank areas of *Watkhal, Kolwadi, Aldore, Golegaon, Somatwadi* and Sawargaon forests. The result is that where there was no seedling growth at all, previous to the introduction of this method, there, now a larger number of seedlings can be seen. The results obtained in these different villages are not uniform. They vary according to local circumstances. The results obtained in the Watkhal and Somatwadi forests are about the best of all, the average seedlings raised therein and aged about four years being one foot in height and two inches in girth. Results obtained in Kolwadi, Aldore, Golegaon and Sawargaon are poorer. In a portion of the Malegaon Forest of the Mawal Range in the Poona Division which was perfectly blank when given out for agri-*cum* Forestry, a fair number of Raiwal seedlings has been raised.

Difference in growth of seedlings visible in the above forests treated under the same method seems to be due to the difference in the depth and the quality of the soil, configuration and the aspect of land, rainfall, the shade available to the seedlings, the care taken of them, the amount of harm received by them from wild animals and stray cattle and other natural causes. In spite of this difference in growth, the results obtained go to prove the utility of the experiment.

This method was also tried in the Dhulia Range of the West Khandesh Division on some bare forest lands given out for cultivation to the Bhils about the year 1909-10 and is reported to have resulted in a fairly good crop of seedlings 3 inches to 18 inches of Anjan, 6 inches to 2½ feet of Khair and 6 inches to 2 feet of Nimb, in height. The Range Forest Officer, Dhulia, says that this is a much better and cheaper method of reboisement of blanks in forests than departmental plantation of any kind.

In the Satpur experiment plantation the same method has been tried for the last several years; the soil here being poor and exposed to the sun the whole day long, the results obtained are not proportionate to the trouble taken. But still results enough to prove the utility of the method in raising plants, where none existed, have been attained.

Selection of lands.

Steep bare hill slopes are totally unsuited for agri *cum*-Forestry. In such places stones cannot be found in sufficiency for erecting 'tals' and when the soil is loosened, there is nothing to keep it back from being washed down by rain-water. Such areas can better be planted up by dibbling under shelter of bushes and sowing in pits and patches and by transplanting seedlings from nurseries into prepared spots. Gentler slopes provided with a sufficiency of 'tals' for protection of soil and flat are peculiarly suited for the operation.

Method of treatment.

The method in which the land is treated for agri-*cum*-Forestry, described in detail in Mr. Osmaston's paper referred to above, may briefly be stated to consist in (i) clearing the land of all inferior growth reserving all healthy trees and seedlings that may be found in it, (ii) thoroughly opening and preparing the soil and (iii) cultivating the soil in the first year for raising cereal crops alone and in the second and third years to raise cereal crops and tree seedlings side by side.

In the hilly lands, further precaution in the way of reserving all growth on the sides of Nalas and one healthy stem out of so many in every bush of Karwand, Henkal, Ukshi, etc., in the remaining area is considered necessary as these stems help to protect the soil to a certain extent and act as nurses to the seedlings to be grown about them. But this is not enough to thoroughly protect the loosened soil from being washed down in the rains: therefore, erecting horizontal 'tals' along the slope is necessary. Loose stones for this purpose are generally found in sufficient quantities in the hill forests; except only in very steep portions of slopes. These stones are carefully arranged in horizontal lines on the ground, about 1 foot to 1½ feet in breadth and from 1 foot to 2½ feet in

height according to the nature of the slope. These 'tals' serve to prevent rain-water from washing down the soil. They are erected by the cultivators and cost them only a little labour. The distances between the 'tals' are fixed according to circumstances of each locality, *viz.*, the gradient of the slopes and sufficiency or otherwise of stones: but an average distance of about 12 feet between the 'tals' has been found to be convenient and useful. Planting of aloe-bulbils along the boundaries of areas subjected to the operation has been found to serve a good purpose. When they grow, they develop into a regular fence keeping out cattle and serve also the same purpose as a 'tal.' The mature leaves of aloe also pay some revenue to the department as they are in demand for fibre-making. In such hilly forests where ploughing is not possible, the soil is opened by pickaxe and prepared by hand.

When tree-seed should be sown.

In the experiments tried by Mr. Osmaston the soil was cultivated in the first year purely for cereal crops, and tree-seed was sown along with grain in the second and third years. But the tree-seed sown was of Raiwal species and germinated soon after sowing and gave pretty big seedlings before cultivation ceased. In the teak forests, sowing of tree seed in the very first year of the operation seems desirable. It is a well known fact that fresh teak seed sown at the commencement of the rains remains in the soil ungerminated for a year or more. Therefore if teak seed be sown in the first year of the operation, there is certainty of getting a fair number of seedlings in the second year. This has been tried in the Junnar forests with success. Sowing of seed is continued year after year till cultivation ceases in order to secure a sufficiency of seedlings and a proper admixture of different species. The seed lines are fixed at convenient distances to permit of cultivation, till the end of the operation, without injury to the seedlings raised.

Selection of seed.

Special care is necessary in the selection and collection of seed, because the subsequent results depend to a great measure on the kind and quality of seed sown.

Treatment of teak seed previous to sowing.

As already stated above freshly collected teak seed sown without any treatment has been found to remain in the soil ungerminated for a year or more. Where speedy germination is sought for attempts at artificial forcing of the teak seed seem desirable.

Various kinds of experiments to secure speedy germination of the teak seed have been tried in the past. The following are some of them :—

(1) Boiling of teak seed and keeping it in water for a number of hours, (2) scorching the seed, (3) keeping the seed in a pit covered with soil for some weeks, watering it from time to time and drying it under shade, (4) exposing the seed to the air through all the seasons for about a year previous to sowing. Of these the last two seem to be the safest for forest subordinates to try.

Last year in the Junnar Range, to see how far method No. 3 could be successful an experiment was tried. A hole, not very deep, was dug in the earth and some freshly collected teak seed was put into it for about a month towards the end of the hot weather in layers, alternated, with thin layers of earth, the top layer being of earth of course. The seed was watered from above the top twice or thrice in a week, sufficient to enable the water to reach the bottom of the hole through all the intermediate layers and to keep the whole mass wet always. At the end of the month the seed was all taken out and kept in the open under shade for about 8 or 10 days and then sown in the forest at the commencement of the rains. This seed produced seedlings before it was long in the soil and in the following September seedlings produced by this seed were seen as good and big as those produced by unprepared seed which was sown a year previously and which germinated along with the seed prepared as above.

Another experiment was tried at Junnar to see how far method No. 4 could be successful. During the fair season of 1912 some teak seed, freshly collected, was kept in the open outside the Range office. This seed was left there till the end of May 1913 and thus was exposed to all the variations of the weather, for over 12 months. No sooner the rains of 1913 set in, this seed began to

germinate freely; and the conclusion arrived at was, that teak seed thus exposed germinated readily and needed only being sown out in the forest before the setting in of the monsoons. Such has been the experience at Junnar where the annual average rainfall is about 30 inches.

Tending seedlings.

The seedlings artificially raised seem to require much more looking after than self-sown seedlings. The weeding done in the rains during the time of the cultivation and the shade provided to the seedlings during the dry months help their growth considerably. At the end of the third year of the operation when cultivation ceases the seedlings of teak and other species growing in hill forests are too tender and tiny to be left to themselves, because they are likely to be choked to death by rank vegetation and grass which are found to grow more vigorously in such areas when cultivation ceases owing to the improved condition of the soil than in areas not so treated. Therefore it seems desirable, if possible, to continue cultivation longer than three years till the seedlings are well established. Because, by this not only the seedlings are freed from the choking influence of rank vegetation and grass, but also the annual opening of the soil for cultivation enables it to absorb more moisture than it ordinarily would; and all this absorbed moisture helps to keep up the seedlings in the hot weather. Besides this, damage to the seedling growth by wild animals and stray cattle is less when the area is in charge of the cultivators. If the cultivation after the third year be not possible for any reason, it seems worth while to encourage the removal of rank vegetation and grass for some years for manure and cattle respectively, whether any revenue can be secured thereby or not, and to annually fire-protect such areas carefully

Soil mulching and providing of artificial shade to the seedlings.

Mr Copleston's experiments in Kanara have proved how soil-mulching combined with artificial shade to the seedlings provided by tying little bundles of grass to small stakes fixed in the ground near the seedlings can be applied to self-sown forest seedlings with advantage. This process has been tried in Poona

Division in some places in the case of artificially raised seedlings with good results; and is therefore being extended wherever new seedlings, natural or artificial, are found. Soil-mulching of the seedlings in agri-*cum*-Forestry lands is done by the cultivators during the time the cultivation continues; and in other places by guards. In the Akola Range of the Poona Division shade is sought to be provided to the seedlings by planting cuttings of Parsi Erand (*Euphorbia*) round the tree-seed sown. The cuttings take root and bear leaves which provide the needful shade to the seedlings. Where cuttings of Parsi Erand are not available in sufficiency seed of that species or even cuttings of Kande-Sabar take their place. Parsi Erand being a fast growing species its seed gives much larger seedlings than the tree-seed and provide shade to the latter. The Parsi Erand or its substitute is meant to be cut when tree seedlings are well established.

Treatment of seedlings after cultivation ceases

Strict closure against grazing agri-*cum*-Forestry areas for about ten years after cultivation ceases and annual fire tracing round them seem desirable. The former might cause complications in the regulation of cattle grazing in forests according to working plans, but the difficulty can generally be met by a little readjustment of grazing areas where necessary and the Divisional Forest Officers must be empowered to do what is necessary in such cases to meet the difficulty.

Co-operation of cultivating public necessary.

To be able to achieve results on a large scale under agri-*cum*-Forestry method, the free co-operation of the cultivating public is necessary. Departmental work in this matter is difficult and prohibitively expensive. At present a few poor people who own little or no lands of their own, principally Thakars and Bhils, come forward to take such lands for experiment. Other classes of cultivators do not care to do it at all and say that the term of three years, for which the lands are given, is too short, considering the trouble that has to be taken and the yield they get in that small period. It is, therefore, an important point to popularise this movement by extending the period of cultivation in the

agri-*cum*-Forestry lands, wherever possible, without injury to the seedling growth and giving some small concessions of grass, etc, in such areas for some years after the cultivation ceases in return for weeding and other necessary operations. In the Junnar Range some four years ago it was a difficult task to induce a band of a few Thakars to take up lands for this experiment Now there is a greater demand there for forest lands for this sort of cultivation. It is a hopeful sign of the movement gaining popularity in forest tracts and patient labour, on behalf of officers of the Forest Department to educate the minds of the people regarding the immediate and future benefits of the operation, seems needed.

Conclusion.

The agri-*cum*-Forestry experiments have conclusively proved that to be able to raise a good crop of tree seedlings in the Deccan hill forests, thorough opening and loosening of the soil thereof is essential previous to sowing of seed. As the normal soil, much hardened owing to want of humus, excessive grazing, undue exposure to the sun caused by broken leaf-canopy and scanty rainfall, cannot absorb enough of moisture in the rains necessary for the support of the seedlings in the hot weather as the opened soil can. Such opening and loosening of the soil is best done by cultivation; therefore whenever there is scope for agri-*cum*-Forestry, it seems worth while to try it by all means; where it may not be possible owing to the area being small and inconvenient, or for want of people to do it, opening of the soil in strips or patches at convenient distances and sowing seed in them, seems the next better thing as has been found to be the case in Junnar and Akola Ranges of the Poona Division, by experiments tried. Where even this is not possible, only pit sowing and dibbling under shelter of bushes has to be resorted to as the next better means of gaining the object In shallow soils, where nothing good will grow it has been found possible to raise seedlings of Sarfal or Salai (*Boswellia serrata*), Khair (*Acacia Catechu*), Henkal and Karwand. The trees and bushes of these species seem to enrich and protect the soil and prepare it in due course of time for seedlings of better species. It,

therefore, seems advisable to try these species on poor shallow soils. It is a matter of frequent occurrence to see seedlings of good species peeping out of Karwand bushes and even Kande-Sabar in some poor forests of the Deccan. The natural improvement in the condition of tree-growth of some of the Deccan forests since afforestment and the results obtained by artificial means have shown that attainment of unbroken leaf-canopy in the forest is a matter of time. If the above methods already tried with a certain amount of success be extended with care and patience, there seems every hope of the Deccan forests being filled in with tree-growth in due course of time and the difficulty of supply of wood being met more easily than now.

Reboisement of blanks in forests is an essential and important matter. The Forest Department is undoubtedly more able to look to it now with its recently strengthened establishment ; more especially because it has now been freed of the control over useless areas that were in its charge. But much more seems to be necessary. Therefore in every Range where the work of reboisement by artificial means is undertaken on a large scale, the employment of a technical Forester with practical training would, it seems, be beneficial. His duty should be to see that the work is properly done in all its details, such as the timely preparation of the soil for reception of seed or seedlings, timely collection of the proper kind of seed, seasonable sowing, transplanting, weeding, soil-mulching and providing artificial shades to seedlings, looking after nurseries, if any, protection of seedlings in forest areas under reboisement and of natural young growth in felled coupes, etc. During short intervals when the Forester may have no work, of the above kind to do, his services can be utilised in the inspection of felling operations, reservation of standards in coupes, etc. The Forester can thus be fully employed throughout the year. Such an appointment is likely to be a considerable help to the Divisional Forest Officer in carrying out his plans for securing artificial regeneration in forest blanks, so much sought for ; and with such a Forester under the instructions and guidance of the Divisional Forest Officer and combined with the co-operation of Range

establishment and people can, it is hoped, be made to do much more useful work for gaining the object aimed at than it seems possible to do now without one.

T. N. KOPPIKAR,
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REVIEW.

NOTE ON THE POSSIBILITIES OF THE OIL-PRESSING INDUSTRY IN THE UNITED PROVINCES.

BY A. H. SILVER, ESQ., DIRECTOR OF INDUSTRIES, UNITED PROVINCES

During the year ending 31st March 1914 the United Provinces exported Castor, Rape, Mustard and other Vegetable oils to the value of more than 26 lakhs of rupees.

There appear to be only two modern oil extraction plants in these Provinces, one of which is not at present working. It is estimated that by the use of a modern plant 4 per cent. to 8 per cent. more oil can be obtained.

Mr. Silver considers that if half the oil-seeds from the various Provinces of India were crushed locally work would be provided for 800 mills of the size of the Premier Oil Mills at Cawnpore working 24 hours daily, while the refuse, *i.e.*, the oil cake would be available as cattle-food and manure.

He further emphasises the fact that Indian conditions are *ideal for oil pressing as oil-seeds give a better quality of oil and a* larger yield when crushed fresh and in a warm climate.

Mr. Silver also remarks that with an abundance of lac increasing quantities of rosin and turpentine and with a large amount of linseed oil available, no country in the world is more favourably situated for the manufacture of paints and varnishes than India, while the "foots" from the oil could be exported as an excellent base for soap. Thus it is suggested that the establishment of oil-presses on modern lines in the United Provinces would form

one of the most attractive commercial propositions in the whole of India

Mr. Silver's note refers of course to cultivated seed, but there can be little doubt that if the seeds of many of our forest trees could be collected and placed at the factory site at a reasonable cost the oil expressed from them would afford scope for starting a paying industry. This appears to be worthy of the attention of Conservators in the various Provinces.

ALCOHOL AND FODDER FROM WOOD.

By proper treatment alcohol can be produced from wood, and the residue may be made to yield a product sufficiently nutritious to serve as fodder for cattle. When mixed with their ordinary dry fodder, it is said to be readily eaten by them. Dr. Joseph Konig, in a recent number of the *Chemiker Zeitung* (Cothen) says: "Materials containing cellulose, especially wood of all sorts, is first treated with dilute mineral acid (hydrochloric or sulphuric) and dilute alkali, preferably ammonia, or with one of these solvents alone and subjected to heating at changing temperatures. The material is then treated further by the well-known sulphite process. The resulting sulphite lye is completely neutralised and sufficiently aerated, and is then subjected, either alone, or, still better, mixed with the first liquid extracted (which is rich in sugar or gum) to the usual process for making fodder (D. R. P. 265, 483). Or if the first extract has been utilised for obtaining alcohol or some other by-product, the residuum is used to mix with the sulphite lye."

From numerous experiments it was found that 100 kilograms of wood yield an average of 4 to 5·5 kilograms of alcohol. The subsequent mixing with calcium sulphate yields from 8 to 15 per cent. of organic matter, according to the kind of wood penetration. About 100 grams of the paste, worth about 10 centimes (2 cents), is required per square meter. The material thus treated is impervious to rain, and easy to clean.—*The Scientific American*.]

THE WAR AND INDIAN INDUSTRIES.

MATCHES

The total import of matches into India in the year ending 31st March 1914 was 13¾ million gross of boxes valued at £597,000. Of the countries affected by the war, Austria-Hungary, Germany and Belgium are included among the exporters of matches to India, but by far the greater part of the imports come from Japan and Sweden. A summary of the statistics for the last five years is given below: –

	Average of three years ending 31st March 1912	1912 13	1913 14.
	1,000 £'s.	1,000 £'s.	1,000 £'s.
Japan	141	261	260
Sweden . .	182	209	182
Austria Hungary ...	61	55	64
Norway	63	76	47
Germany	21	22	17
Belgium	9	16	14
United Kingdom ...	5	4	6
Straits Settlements ...	79	12	5
Other countries ...	1	1	2
Total . .	562	656	597

In 1912-13 the total quant.ty imported was 15 million gross of boxes, and this is by far the largest import on record. The decrease in imports last year is probably due to a great extent to the passing of the Indian White Phosphorus Matches Prohibition Act (No. V of 1913). The object of the Act was to bring India into line with the great majority of civilised countries where the manufacture, import and sale of such matches is prohibited on account of the danger of the disease "phossyjaw" or "necrosis" to which workers exposed to white phosphorus fumes are liable. The principal countries which exported these matches to India were Japan, Sweden and Norway, the two latter countries allowing the

manufacture of white phosphorus matches for export only. It is a striking tribute to the energy with which Japan has set herself to capture the Indian match trade that although, prior to last year, a considerable proportion of the matches exported to India were white phosphorus matches, her exports to India last year show scarcely any decrease, the place of the white phosphorus matches having been taken by an almost equal quantity of other matches.

The effect of the war on the match trade has been practically to cut off the supplies from Austria-Hungary, Belgium and Germany and also to diminish, temporarily at any rate, the imports of matches from Japan, as it is believed that there has been difficulty in obtaining some of the materials necessary for the industry, including some of the chemicals and a supply of suitable paper for covering the boxes.

Retail prices of matches in India have always been governed more or less directly by the importer's prices. The rise in the latter, since the outbreak of the war up to the end of September 1914, was 9 per cent. in the case of Swedish matches and 8 per cent. in the case of Japanese matches. The average of the declared values of matches from these countries during the months of July, August and September was as follows :—

	July.	August.	September.
	Rs. a. p.	Rs. a. p.	Rs. a. p.
Sweden, per gross ...	0 12 7½	0 14 9	0 13 9
Japan " ...	0 8 10	0 9 2	0 9 6

These figures show also that the Japanese match is very much cheaper than the Swedish match. The cheaper classes of Japanese sulphur matches, prior to the war, were priced as low as 6½*d.* to 7*d.* per gross c. i. f. More expensive qualities were from 9*d.* to 10*d.* per gross. Swedish matches are about ½*d.* to 1*d.* per gross on the average dearer than Austrian matches Some of the principal brands of Austrian matches with their prices, prior to the war, are given below :—

Safety Matches.—

Pipe, Rex, Renowned, Cigar, Scissors Brands.—11½*d.* per gross c. i. f. Calcutta.

Honooman, Lamp, Saw, Three Locks Brands. —11*d.* per gross.

Sulphur Matches.—

Essabhoy's, Diaslai, Barsati, Cowry Brands.—11*d.* per gross.

Pojatzi, Telegraf Brands.—10½*d.* per gross.

The matches imported into Calcutta from Germany are only "Bengal Light" and "Brilliant Star" pyrotechnic matches, the prices of which are as follows:—

Bengal Light matches—2*s.* 6*d.* per gross c. i. f.

Brilliant Star matches—3*s.* per gross c. i. f.

These are utilised chiefly for amusement and the demand for them is greatest during festivals. Similar matches are made in India and are understood to have a good sale. The prices of some Indian-made brands delivered at Calcutta were ascertained to be—

Bengal Light matches—Re. 1-6-0 per gross.

Brilliant Star matches—Re. 1-10-0 per gross.

In quality they do not appear markedly inferior to the imported German match.

The existence of a very large market for matches in India is proved by the import figures quoted above and much attention has recently been directed to this industry in India. In 1910 Mr. R. S. Troup published a note on "The Prospects of the Match Industry in the Indian Empire, with particulars of proposed Match Factory Sites and Woods suitable for Match Manufacture." This contained much useful information regarding the suitability of Indian woods for match manufacture, details regarding match-making machinery and the conditions which might affect the industry in different parts of India. The conclusions which Mr. Troup drew regarding the prospects of the industry in India were optimistic, and since the publication of his note several new match factories have been started in India, notably one at Mandalay and one in the United Provinces, whose fortunes will be observed with interest. It would be unwise, however, to underrate the difficulties which still beset the industry in this country.

The question of finding woods entirely suitable for match manufacture cannot yet be said to have been finally solved and much detailed experiment in the treatment of Indian woods will remain to be done by those who are pioneering this industry. The chemical difficulties also attending the treatment of match heads especially in the rainy season cannot be solved except by actual experience and experiment. At the same time these factories and others which were previously in existence have demonstrated the possibility of making matches in India fully equal in quality to the best imported matches, and there is reason to hope that in the match trade India will eventually be independent of foreign imports. The above considerations, however, indicate that there is a considerable risk of loss in this, as in other new industries, if attempts are made to start companies on insufficient capital, since the expenses of the first few years of working are likely to be heavy.—[*The Indian Textile Journal.*]

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SOME FINANCIAL ASPECTS OF RESIN-TAPPING IN CHIR PINE FORESTS.

BY E. A. SMYTHIES, I.F.S.

The rapid and extensive development of the Resin Industry in the U. P. and Punjab, a development which yearly increases the importance of this Departmental Industry, suggests that the time is opportune to examine the financial aspects of the resin-tapping, a subject which has not, so far as I know, been examined at all up to date. What is the total value of the resin produced in the lifetime of a tree? How and to what extent does the revenue from resin affect the rotation under which the Himalayan Pine forests should be worked? What is the correct financial rotation for Chir?

An attempt has been made in this note to answer these and similar questions, a pioneer attempt, and therefore admittedly inadequate. But the object of this note will have been achieved if fresh light is thrown on a somewhat complex, but nevertheless important, problem.

2. The data on which subsequent calculations have been based are those which now exist in the Naini Tal Sub-division in the U. P., where the Resin Industry is more intensively developed than elsewhere, and where the revenue obtained from the resin yield exceeds all other sources of revenue put together. Conditions must of necessity vary with locality, and the data taken here would not be strictly accurate for other localities, and for the sake of comparison a duplicate set of calculations have been made in the following note, showing in one set the results where the resin operations show the maximum profit, and in another the result where a more or less average profit is obtained.

3. The data adopted are as follows :—

(*a*) *As regards the standing crop*—

TABLE A.

Girth.	Corresponding age.	No. of trees per acre.	Sale value of standing trees.	REMARKS.
			Rs. a. p.	
4′	80	141	3 0 0	The figures for number of trees per acre are those given by the Forest Sylviculturist for a fully stocked acre of this quality class and the age of trees from figures obtained by the Forest Sylviculturist and by the writer. The sale value of standing trees from the new Naini Tal Working Plan.
4′ 6″	90	117	4 8 0	
5′	102	103	6 0 0	
5′ 6″	120	95	8 0 0	
6′	145	92	10 0 0	

(*b*) *As regards resin yield.*—Light tapping is commenced at girth 3′ 6′ (age 70 years) by putting one channel per tree, and tapping is thenceforward continuous. Heavy tapping is commenced five years before the tree is to be felled, by putting on as many channels as possible.

One channel gives two seers of resin per annum, the gross value of which is six annas.

The *nett* value per channel per annum varies according to the distance of the resin coupe from the distillery. For the Naini Tal Sub-division it may be taken at an average of 50 per cent. of the gross value, *i.e.*, 3 annas per channel per annum, the other 3 annas representing expenditure on tapping and collection, carriage, distillation, management, etc., *i.e.*, all expenditure on the Resin Industry only, but not expenditure on ordinary forest management.

The Naini Tal Sub-division is typical of an area from which maximum resin profits are obtainable. For the Punjab forests and the Kumaun forests generally a *nett* profit of about $33\frac{1}{3}$ per cent. only can be expected, or say 2 annas per channel per annum. In subsequent calculations, therefore, where *nett* profit is taken into consideration, the results have been worked out for both 50 per cent. and $33\frac{1}{3}$ per cent. profits.

(*c*) *Miscellaneous data.*—It is assumed that the tree is sold and felled immediately after the last year's resin yield have been obtained, so that no interest is calculated thereon.

The general rate of the interest is taken at $3\frac{1}{2}$ per cent., *i.e.*, intermediate yields are put out at $3\frac{1}{2}$ per cent. compound interest.

4. With the above data, a number of different facts may now be ascertained.

Let us first consider the value of the resin yield obtained, from a single tree, according as it is felled at 4′ or 4′ 6″ or 5′ girth, etc. Tapping starts at age 70, therefore at 4′ girth (age 80) there will have been five years light tapping with one channel, and five years heavy tapping with two additional channels. The *gross* value of this ten years' resin yield when the tree is felled will, therefore, be (in annas)—

$$= 6 \times (1{\cdot}035^9 + 1{\cdot}035^8 + \ldots + 1{\cdot}035^5).$$
$$= 12 \times (1{\cdot}035^4 + 1{\cdot}035^3 + \ldots + 1)$$
$$= 102{\cdot}7 \text{ annas} = Rs.\ 6{\cdot}4.$$

Similarly at 4′ 6″ girth (age 90), we get 15 years light tapping, and five years heavy tapping with two channels (the three previous channels will not yet have healed up) and the resin yield will be worth $6 \times (1{\cdot}035^{19} + \ldots\ldots + 1{\cdot}035^5) + 12 \times (1{\cdot}035^4 + \ldots + 1)$ annas = Rs. 12·7. At 5′, 5′ 6″, and 6′ girth we shall be able to get

respectively 3, 4 and 5 channels with heavy tapping (always bearing in mind that three channels from light tapping will still remain not healed up), and the period of light tapping will be respectively 27, 45 and 70 years, with the same formula as above,* the resin yield at the time of felling will be in value—

for 5′ girth (age 102 years) = Rs. 25·6.
„ 5′ 6″ girth (age 120 years) = Rs. 55·3.
„ 6′ girth (age 145 years) = Rs. 138·2.

This is one somewhat unexpected result of the effect of compound interest acting on considerable intermediate yields over long periods of time. Without allowing any interest, the total gross resin receipts from a 6′ tree, for example, amount to Rs. 35·6 only, which compound interest at $3\frac{1}{2}$ per cent. increases to nearly Rs. 140.

5. It will however doubtless be urged that we are more concerned with nett profits than with gross receipts. This is true. The nett profits from the data given will obviously be 50 per cent. and $33\frac{1}{3}$ per cent. respectively of the gross receipts, *i.e.* :—

	50 per cent.	$33\frac{1}{3}$ per cent.
	Rs.	Rs.
For a 4′ tree	3·2	2·1
„ 4′ 6″ „	6·3	4·2
„ 5′ „	12·8	8·5
„ 5′ 6″ „	27·7	18·4
„ 6′ „	69·1	46·1

6. Let us now consider what effect resin work has on the financial rotation of Chir forests. By financial rotation is meant the period at which the indicating per cent. falls below the general per cent., which in our case is $3\frac{1}{2}$.

* The actual formula in each case is –

for 5′ $= 6 \times (1{\cdot}035^{31} + \ldots\ldots + 1{\cdot}035^{5}) + 18 \times (1{\cdot}035^{4} + \ldots\ldots + 1)$.
„ 5′-6′ $= 6 \times (1{\cdot}035^{49} + \ldots\ldots + 1{\cdot}035^{5}) + 24 \times (1{\cdot}035^{4} + \ldots\ldots + 1)$.
„ 6′ $= 6 \times (1{\cdot}035^{74} + \ldots\ldots + 1{\cdot}035^{5}) + 30 \times (1{\cdot}035^{4} + \ldots\ldots + 1)$.

We shall obtain sufficiently accurate results from the formula :—

$p = 100\sqrt[n]{\frac{W}{w}} - 100$, where p = indicating per cent.
n = the period.
W = value of 1 tree at end of period.
w = value of 1 tree at beginning of period.

Using this formula, and neglecting for the moment all results from resin work, *i.e.*, considering only timber we get :—between 4′ and 4′ 6″ (where the tree increases in value in 10 years from Rs. 3 to Rs. 4-8-0).

$$p = 100\sqrt[10]{\frac{4 \cdot 8}{3}} - 100 = 4 \cdot 14\ \%$$

Similarly between 4′ 6″ and 5′

$$p = 100\sqrt[12]{\frac{6}{4 \cdot 8}} - 100 = 2 \cdot 43\ \%$$

From this it is clear that the financial rotation should be about 90 years, *i.e.*, when the trees are 4′ 6″ girth, which in point of fact means, for the local conditions, as soon as ever the trees are saleable (since there is practically no demand for trees below this girth).

Let us now consider the influence of resin profits.

Girth of trees.	Timber value.	Nett resin value. (a) At Rs. 50 %	Nett resin value. (b) At Rs. 33⅓ %.	Total value of trees. (a) At Rs. 50 %.	Total value of trees. (b) At Rs. 33⅓ %.
	Rs.	Rs.	Rs.	Rs.	Rs.
4′	3	3·2	2·1	6·2	5·1
4′ 6″	4·5	6·3	4·2	10·8	8·7
5′	6	12·8	8·5	18·8	14·5
5′ 6″	8	27·7	18·4	35·7	26·4
6′	10	69·1	46·1	79·1	56·1

Utilising the above formula, we get—

		(a)		(b)
between 4′ and 4′ 6″	p =	5·71	and	5·49
" 4′ 6′ " 5′	p =	4·68	"	4·35
" 5′ " 5′ 6″	p =	3·66	"	3·38
" 5′ 6″ " 6′	p =	3·23	"	3·06

From these results we see—

(*a*) that the financial rotation for the 50 per cent. areas has been increased to over 120 years, and for $33\frac{1}{3}$ per cent. areas to between 102 and 120 years ;

(*b*) that, as we might expect, from areas of smaller resin profits the influence of resin profits on lengthening the rotation decreases.

7. It should, however, be noted that the above formula was worked out for short periods only, thinning and intermediate yields being therefore eliminated, and for long periods, in the course of which thinnings would almost certainly be carried out, the formula would not apply, and it can be argued with considerable force that the removal of a certain number of trees in thinnings, which would not thereafter produce resin, would materially affect the results arrived at.

8. In point of fact, however, this makes scarcely any difference, and to prove this, since we have full data available for the calculations per acre, it will be of interest to work it out, and see the actual effect.

From the data already given above, we find that—between 4′ and 4′ 6″, 24 trees are removed per acre.

Let us assume that these are felled immediately after 4 feet, then their total *nett* value will be—

$24 \times 6{\cdot}2 =$ Rs. 149 and $24 \times 5{\cdot}1 =$ Rs. 122·4.

In a similar manner we can ascertain that the intermediate

	(a)	(b)
	Rs.	Rs.
yield of 14 trees at 4′ 6″ will be worth	151·2	121·8
" 8 " 5′ " "	149·6	116·0
" 3 " 5′ 6′ " "	107·1	79·2
" 1 " 6′ " "	79·1	56·1

We are now in a position to prepare a financial yield table for 1 acre of Chir pine, and to utilise figures already obtained, we may reckon the resin value of trees remaining at the end of the rotation as final yield, and the resin value of trees removed in thinnings as intermediate yield. It is further assumed that there is no saleable intermediate yield before the trees were 4′ girth.

TABLE B (for 50 per cent. profits).

Girth.	Age.	No. of trees per acre.	Value per tree, including resin yield with interest.	Inter-mediate yield.	Sum of intermediate yield with compound interest to date.	Final yield.	Total yield.
			Rs.	Rs.	Rs.	Rs.	Rs.
4′	80	141	6·2	149	149	725	874
4′ 6′	90	117	10·8	151	361	1,112	1,473
5′	102	103	18·7	150	696	1,776	2,472
5′ 6″	120	95	35·7	107	1,400	3,284	4,684
6′	145	92	79·1	79	3,387	7,198	10,585

TABLE B (for 33⅓ per cent. profits).

4′	80	141	5·1	122·4	122·4	596·7	719·1
4′ 6′	90	117	8·7	121·8	294·4	896·1	1190·5
5′	102	103	14·8	116·0	560·8	387·5	1948·3
5′ 6″	120	95	26·4	79·2	1220·6	2428·6	3649·2
6′	145	92	56·1	56·1	2884·5	5105·1	7989·6

The indicating per cent. from column 8 for different periods work out as follows:—

			Indicating per cent. calculated in para. 6.	
	(a)	(b)	(a)	(b)
Between 4′ and 4′ 6″ p =	5·36	5·17	5·71	5·49
,, 4′ 6 and 5′ p =	4·39	4·19	4·68	4·35
,, 5′ and 5′ 6′ p =	3·63	3·45	3·66	3·38
,, 5′ 6′ and 6′ p =	3·32	3·18	3·23	3·06

It will be noted, first, that the difference in indicating per cent. by the two methods of calculation, *i.e.*, in the one case by data from single trees and omitting thinnings, and in the other case by data for a stocked acre, and including thinnings, is so small as to be negligible.

This further confirms us in the conclusion we had already arrived at, *i.e.*, even when the financial rotation—as regards timber only—culminates as soon as the trees are saleable, yet when resin results are included, the financial rotation is extended considerably—except of course where only large timber is saleable, and a long rotation has to be adopted in any case. Looked at in another way it amounts to this, in every rotation there will be a hiatus of 70 years when no resin will be obtainable. So that it pays us to keep the trees standing after tapping has started, after they are otherwise financially ripe, while they continue to produce resin, since the resin results outweigh the importance of timber production and of the maximum mean annual increment of the forest, at any rate from the most favourable areas, and even in less favourable areas, the resin results are important, and cannot be ignored.

9. There is another method of testing the financial rotation which may be briefly referred to, since it checks the conclusions we have already obtained. The financial rotation of a forest is that which gives the maximum soil expectation value. Taking 8 annas per acre as the cost of all expenses of management (*i.e.*, A-VII, VIII, IX-B), and utilising the data already obtained and treating the total yield of column 8 in Table B as a single final yield, we get :—

With a 80 years' rotation $$Se_{80} = \frac{874}{(1{\cdot}035)^{80} - 1} - \frac{1/2}{{\cdot}035} = 45{\cdot}1$$

		(a)	(b)
Similarly	Se_{80}	= 45·1	34·6
	Se_{90}	= 56·0	42·1
	Se_{101}	= 61·9	50·8
	Se_{120}	= 62·2	45·6
	Se_{145}	= 58·3	40·6

This corroborates the results already obtained. It is moreover noticeable how the lower resin profits decrease the soil expectation value.

10. The question naturally arises in one's mind what the effect would be if the forests were managed so as to reduce this great hiatus as far as possible. Since it is the girth of a tree and not its age which decides when tapping operations should start, obviously early and heavy thinnings would enable the trees to reach a tappable girth at an earlier age, and the hiatus would thereby be shortened materially. There are unforunately no data of comparative thinnings available which would enable us to examine this question in detail, but personally I feel convinced that in forests managed for resin, very heavy thinnings from an early age, with the object of developing a large girth increment and the development of tappable trees in the shortest possible time, would be the soundest method of management. This is what is actually done in the resin-producing Maritime Pine forests in France.

11. It is for example evident that if by heavy thinnings we can reduce the time required to obtain any particular girth by, say, 20 per cent., then the tapping will commence 14 years earlier (*i.e.*, at 56 years age) and a 6 ft. tree will be obtained 29 years earlier, *i.e.*, at age 116. The tapping period will thereby be reduced by 15 years. Similarly for a 5 ft. tree, the tapping period will only be reduced by six years.

Let us now assume that by carrying out heavy thinnings in our Chir forests the girth increment of the standing crop is increased by 20 per cent., and with an intense light-demander such as Chir, whose increment is immediately affected by crowding, this is a very fair assumption.

By similar calculations to those already carried out and with these altered data, we obtain the following Table C.

TABLE C (for 50 per cent. and 33⅓ per cent profits).

Girth.	Age.	No. of trees per acre	Value per tree. Timber.		Value per tree. Resin yield to date		Total.	Value.	Indicating per cent.	
			Rs.	a.	(a)	(b)	(a)	(b)	(a)	(b)
4′ 6″	72	Unknown but less than the figures given in Table B.	4	8	5·0	3·3	9·5	7·8	5·15	4·83
5′	82		6	0	9·7	6·5	15·7	12·5	3·42	3·17
5′ 6″	96		8	0	18·9	12·6	26·9	20·6	3·05	2·83
6′	116		10	0	39·0	26·0	49·0	36·0		

From this table, since obviously a wood with a 5′ 6″ girth is now over ripe, and the correct girth has been reduced to somewhere about 5 ft., it is evident that the effect of heavy thinnings will be to shorten materially the financial rotation by a *double* action (*a*) of increasing the girth increment and (*b*) decreasing the girth when the wood is financially ripe.

12. It is unfortunately impossible to compare the actual financial results (*e.g.*, the soil expectation value) between Tables B and C since we have no methods of knowing to what extent we should have to reduce the density of the standing crop to produce this large girth increment, but there can be little doubt that the financial results would be better, since we should begin to get revenue at 56 years instead of 70, or 14 years earlier, a fact that adds over 60 per cent. to the *present value* of the resin yield, and thus an important factor in calculating the soil expectation value.

If this argument is sound, we have, I think, established an important point, and one which will materially affect the method of management of our Chir forests, and the conclusion arrived at—*i.e.*, early and heavy thinnings to develop large girth increment—cannot be over-emphasised.

That the French have realised this important point is brought out in an emphatic manner by the method of management in the great resin-producing forests of Landes. There the growing stock is frequently and heavily thinned, and Mr. Troup gives the following figures for density of stocking:—

Age.	No. of trees per acre.	REMARKS.
20 ...	223	Compare these figures with the figures given in Table A for fully stocked Chir.
30 ...	131	
35 ...	111	
40 .	91	
45 ...	81	

13. A question that is frequently asked, but to which no attempt to give an answer has yet been made, is: What is the effect of the resin yield on the annual *nett* income from Chir forests?

The data given in Table B enable us to calculate this out, and for this calculation light tapping is taken as an intermediate yield (and also for simplicity, one channel of heavy tapping) and heavy tapping, less one channel, is taken as final yield. The formula for obtaining the annual income of a forest is of course

All receipts *minus* all expenses.

Rotation.

TABLE D (for 50 per cent. profits).

Period.	Intermediate yields.		Final yield.		Total yield (?).		Total.
	Timber.	Resin.	Timber.	Resin.	Timber.	Resin.	
	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
71—80 ..	...	264	423	130	423	396	819
81—90 ..	72	219	527	110	599	593	1,192
91—102 ..	63	232	618	193	753	908	1,661
103—120 .	48	321	760	269	943	1,305	2,248
121—145 ...	30	431	920	345	1,133	1,812	2,945

(*a*) Total yield = final yield plus *all* intermediate yields.

TABLE D (for $33\frac{1}{3}$ per cent. profits).

Period.		Intermediate yields.		Final yield.		Total yield (*a*).		Total.
		Timber.	Resin.	Timber.	Resin.	Timber.	Resin.	
		Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
71—80	...	...	176	423	87	423	263	686
81—90	..	72	146	527	73	599	395	994
91—102	..	63	155	618	129	753	606	1,361
103—120		48	214	760	170	943	870	1,813
121—145	...	30	287	920	230	1,133	1,208	2,341

Taking again 8 annas per acre per annum as all expenses of management we get the figures of nett annual income as follows :—

Rotation.		Timber only.	Timber plus Resin.		Resin only.		REMARKS.
			(*a*)	(*b*)	(*a*)	(*b*)	
		Rs.	Rs.	Rs.	Rs.	Rs.	
80	I —	4·8	9·7	8·1	4·9	3·3	In both cases it will be noted that there is a steady rise in the nett annual income from resin to the maximum age.
90		6·0	12·7	10·9	6·7	4·9	
102	...	7·1	15·8	12·8	8·7	5·7	
120	..	7·44	18·4	14·6	10·96	7·16	
145	...	7·38	19·9	15·6	12·52	8·22	

Again we see, as we might expect, the effect of resin profits raising the rotation. It is also interesting to note that the resin revenue more than doubles the *nett* annual revenue with the longer rotation and the figures for the longer rotation are high, even when judged by European standards. It is scarcely necessary to point out that in actual practice it will be many years before these figures are obtained, since our Chir forests, although rapidly filling up, are still far from completely stocked.

In the writer's opinion, also, the figures of numbers of stems per acre given in Table A (which are taken from the Forest Sylviculturist's figures) are, especially as regards the older age-classes, excessive. Even, however, if we make a 33 per cent. deduction in the growing stock (and consequently in the *nett* annual income) we are still left with very handsome financial results.

14. Resin production in the U. P. and the Punjab is already approaching 5 lakhs of gross revenue per annum, and in a short time will equal 8 to 10 lakhs, but even this development will be dwarfed in the course of years, as the forests become fully stocked and heavy tapping becomes fully developed. A rough idea of the possibilities of the Resin Industry can be obtained from the number of channels per acre in a normal fully stocked Chir forest.

From Table D it is evident that with 145 years rotation, the total number of channels would be —

light tapping $(141 \times 10) + (117 \times 10) + (103 \times 12) + (75 \times 18) + (92 \times 25)$

heavy tapping $(24 \times 5) + (14 \times 5) + (8 \times 10) + (3 \times 15) + (92 \times 4 \times 5) = 7466 + 2155 = 9621.$

Therefore average number per acre $= \dfrac{9621}{145} = 66.$

This is more than double our present average, and even allowing a 33 per cent. reduction, this would give a *gross* annual revenue of over Rs. 16 per acre Since there are not less than 200,000 acres of workable Chir forests in British India, a gross revenue of one-third of a crore of rupees appears not impossible in the course of years.

15. There are many other aspects of the financial effects of resin tapping, which it would be interesting to examine, but this note has already become of inordinate length, nor is it meant to be a comprehensive treatise of the subject.

Let us therefore briefly summarise the points established :

(*a*) The gross value of resin yielded by a Chir tree, at age 145, amounts (inclusive of compound interest at $3\frac{1}{2}$ per cent.) to Rs. 138, and the nett value under the conditions of the Naini Tal Sub-division to Rs. 69, and for average areas Rs. 46.

(*b*) The effect of the revenue from the resin-tapping is to increase considerably the financial rotation of the forest, except in cases where a long rotation is required for other reasons, *e.g.*, when only trees of large girth are exploitable.

(*c*) Anything to shorten the long gap before the tapping commences, *e.g.*, heavy thinnings will tend to shorten the rotation and will be financially profitable.

(*d*) A normal fully stocked Chir forest under the favourable conditions which obtain near Naini Tal may be expected to produce a nett annual revenue of Rs. 16 to Rs. 20 per acre, of which the resin yield alone contributes from Rs. 9 to Rs. 12. In areas which are not so favourably situated, and from which only one-third of the gross receipts of resin work can be taken as *nett* profit (and this would apply to a very large proportion of the forests at present being worked), the financial results from the Resin Industry alone would still amount to Rs. 5 to Rs. 7 per acre per annum nett profit.

(*e*) The Resin Industry in India should in course of time produce a gross annual revenue of Rs. 30 to 35 lakhs.

(*f*) Finally, the main object of this note may be briefly expressed. In past Working Plans for the management of Chir forests, the effect of resin work and the importance of resin work have been practically

ignored. For some inaccessible forests (*e.g.*, the Jaunsar forests) this was of no consequence, since a too expensive lead for the crude resin reduces the nett profits to a negligible factor. But in very extensive areas of Chir forest, both in the Punjab and the U. P., the resin results will be a very important factor in the working of these forests, and in the most favourably situated forests, *i.e.*, those nearest to the distilleries or rail-heads, the nett resin receipts may be expected to exceed the timber receipts. It is therefore important that the financial results of resin should be taken more into account, and if this note results in a recognition of this fact, its object will have been attained.

THE UNIFORM SYSTEM IN BURMA.

BY H. C. WALKER, I.F.S.

In the *Indian Forester* for October 1915, Mr. Blanford has cheerily stated that I have "entirely misrepresented the whole question and that the immediate adoption of the Uniform system is not contemplated." As I do not profess to be in favour of the Uniform system, I am relieved to receive such a definite assurance on this point, but perhaps I may be allowed to defend myself against the charge of misrepresentation.

In the memorandum explaining his proposals Mr. Troup quoted the views of the then Inspector-General as follows :— "The only way to realise the undoubted benefits arising from fire-protection and to maintain the teak in these forests is to change the method of treatment. The teak, being a light-demanding tree which cannot establish itself under the shade of the bamboos and of the many species with heavy cover with which it is associated, is not adapted to treatment by the Selection method combined with fire conservancy. The flourishing Taungya plantations of even-aged teak poles, some of them now some

forty years of age, show us that it is quite possible to grow even-aged crops of teak, and though it is not possible at present to say whether this plantation teak will at maturity yield such valuable timber as can be obtained from the natural forests hitherto overrun by fire, there is reason to hope that it will do so. Whilst abandoning fire conservancy in this class of forest, I would therefore endeavour to aim at establishing young growth over a certain proportion of each working circle or forest unit, by concentrating on it plantations, improvement-fellings and other measures, such as sowings and dibblings, undertaken to induce reproduction. So soon as satisfactory young growth has been obtained over the area thus set aside for regeneration, fire-protection should again be enforced." In the next paragraph Mr. Troup stated that "it now remains to suggest how the measures referred to above might be carried out in practice."

Surely it is clear from this that the scheme was put forward for the purpose of solving the vexed question of fire-protection. The Inspector-General pointed out that teak can be grown in even-aged crops and suggested measures which he evidently considered would result in even aged crops. His reasons are equally obvious. He recognised that fire-protection benefited inferior species rather than teak, and had proved a failure in the existing type of jungle where the struggle is very severe. He was evidently impressed, however, with the desirability of preventing the direct injury caused by fire, and it was primarily for this reason that he proposed to substitute a series of more or less artificial even-aged woods in place of the existing natural jungle. I am regarded as an extremist on the question of fire-protection, but I have never denied that fire is frequently harmful to the individual tree, and therefore even I am quite prepared to admit that if uniform woods of the German type were established in which the struggle for existence could be carefully regulated, such woods might be protected with advantage. Given these views and objects however, it seems to me that a compromise is impossible. Merely to tinker with the jungle, and to give some slight assistance to one particular age-class in order to facilitate a task which our

successors some six or seven generations hence may or may not attempt to carry out does not conform with these views.

Mr. Troup was at the time Imperial Superintendent of Forest Working-plans, and as an expert merely worked out these views and showed how "the measures referred to above might be carried out into practice." His proposals, as I understand them, comprise three methods. Where regeneration already on the ground is sufficient to form a uniform crop, he proposed merely to remove the overwood and to assist the seedlings until out of the reach of the bamboo. Where regeneration is deficient he proposed to make regeneration fellings round seed-bearers, and finally where there are no seed-bearers and no regeneration he proposed to resort to purely artificial methods of reproduction, such as dibblings, plantations, etc. Such measures, if properly carried out, are calculated to result in practically even-aged crops throughout the coupe, and therefore conform with the Inspector-General's views.

In the scheme as it finally emerged from the Conference it was stated that "the method of treatment adopted is a conversion from irregular high forest into high forest containing a series of even-aged woods over whole compartments." This language is clear and concise, and can hardly be construed into meaning that the Conference desired to postpone conversion for 150 years, and in the meantime to carry out work which would facilitate conversion at the end of that period. It was also stated that the first object sought to be attained was "to ensure the reproduction of teak in sufficient quantity and at the same time *to secure such advantages as may result from fire protection.*" This is not quite so clear, but in view of the original proposals I think the natural interpretation is that the Conference sought to ensure reproduction sufficient to create uniform woods, and did so for the purpose of securing such advantages as may result from fire-protection, and in fact approved of the object which the Inspector General wished to attain by the change of treatment.

Incidentally it may be noted that the Conference proposed to apply this treatment, not to a freak forest of small size in which the teak happens to be peculiarly suited for conversion, but to all

the forests in the Tharrawaddy Division. These forests have always been regarded as typical of the best class of teak forests, and are the most famous forests in Burma, and perhaps even in all India. Hence if such treatment were considered suitable for these forests, it was to be expected that similar treatment would gradually be adopted in other forests throughout the Province.

In only one respect was the original scheme materially amended, namely, that the proposal to sacrifice immature teak was eliminated. The fact that such a proposal was made proves that it was intended to make a clean sweep of the overwood. Mr. Blanford asserts that the Conference passed a resolution to the effect that the immediate adoption of the Uniform system would necessarily entail the sacrifice of immature stems, but although I have looked carefully through the proceedings, I am unable to find any such expression of opinion. I have myself seen in the Tharrawaddy Division plantations in which the Taungya cutters had carefully left all immature teak stems, in fact it was, I believe, Mr. Troup, my D. F. O. at the time, who drew my attention to the fact and pointed out the great damage caused to the new crop. It does not necessarily follow, therefore, that because the Conference opposed the proposal to fell immature teak, the idea of immediate conversion was abandoned.

When the proceedings of the Conference were submitted to the Government of India, so far as I remember the Inspector-General pointed out that it was a fundamental axiom of Forestry that a change of system must involve sacrifice, and refused to accept the amendment. Presumably he read through the proceedings carefully, and he at least seems to have concluded that the Conference was in favour of the immediate adoption of the Uniform system merely with the proviso that immature trees should be left standing above the new crop.

Since the Conference there has been an entire change of personnel of those who direct our forest policy. In order to prove, therefore, that the idea of the immediate adoption of the Uniform system has not been definitely abandoned I give quotations from the present Inspector-General's note on his tour of inspection in

Burma in which he tendered his advice to the Local Government as to the best treatment for the teak. He states that "it seems to me to be proved that the combination of the Selection system with fire-protection has failed, and that the time has come to make a start with a more up to-date method of treatment, based on the known sylvicultural requirements of the teak. It is true that in areas *where continuous cleanings and improvement fellings are carried* out the Selection system will give better results than it has in the past: but considering the danger of suppression and the unavoidable damage to be caused by the recurrence of felling and extraction once in each period, these results cannot be so satisfactory as those to be obtained within a limited regeneration period by the *removal of all trees except groups of poles or of young trees which* can be left to grow on throughout the rotation."

I have not seen the Mohnyin reserve, but I believe that its principal interest lies in the fact that an attempt is there being made to carry out an immediate change of system. I understand that within the last five or six years this reserve has been visited by the Inspector General and by three different Chief Conservators, and by the latter more than once, and it is somewhat difficult to believe that these high officials who have practically unlimited discretion in moulding and directing our forest policy take the same view as Mr. Blanford and consider this experiment to be of no immediate practical interest, or that these frequent visits to a notoriously unhealthy locality are made merely to record data for their successors 150 years hence, "should it then be decided to introduce the Uniform system."

I have not, however, gone into this question in such detail to clear myself of the charge of misrepresentation, but because I think there has been a great deal of genuine misunderstanding. There is in my opinion no gainsaying the fact that we *did* adopt for the forests of one of the most important divisions in Burma a method of treatment which involved the immediate conversion of these forests into uniform woods, or that we committed ourselves to the opinion that the object we sought to effect by the change was "to secure such advantages as may result from

fire conservancy." I think, however, that we were induced by Mr. Troup's engaging personality to commit ourselves further than we intended or perhaps realised at the time, and I do not believe that the scheme as finally adopted by the Conference at all represents our real views. I very much doubt, for instance, whether there is a single forest officer in Burma who really believes that "such advantages as may result from fire conservancy" are of such colossal importance as to justify such a drastic measure as the gradual conversion of our existing natural forests into even-aged woods. Even Mr. Troup himself subsequently repudiated this idea. But if a change of system is not called for in order to solve the vexed question of fire-protection, on what grounds can it be justified? Mr. Blanford points out that "wherever forest management has been carried on for any long period, whatever the species, light-demander or shade-bearer, the Selection method originally necessary since all virgin forests are uneven-aged has given place to some type of the Uniform system." But unless more substantial reasons can be given, this merely amounts to an admission that we are reduced to an abject and unintelligent imitation of German forests.

There has certainly been a great deal of talk about the Uniform system, but possibly little will be done. The Conference with a great flourish of trumpets adopted a scheme to be applied to all the Tharrawaddy forests, but I have not heard that this scheme is being carried out. Mr. Blanford informs us that in his division work is being carried out in accordance with what he considers were the views of the Conference, but generally throughout the Province work seems to be going on very much as before.

As regards the particular views put forward by Mr. Blanford however, I understand that he maintains that the majority of forest officers were suddenly converted to an intermediate method of treatment calculated to lead to the adoption of the Uniform system 150 years hence. He justifies his contention by referring to the resolutions of the Conference, and does so in a manner which may perhaps convey the impression that he is quoting the actual words used. This is far from being the case. There

certainly was a resolution to the effect that improvement fellings should be concentrated and repeated, but I am unable to find his second resolution to the effect that work should be carried out only once in the course of the rotation, nor in his third resolution can I find any statement condemning the immediate adoption of the Uniform system.

The question arises, therefore, what was understood by concentrating and repeating improvement fellings. The term "improvement fellings" has always been used in Burma—at least *until the Conference—to mean the freeing of teak and other species* of marketable value of all ages from suppression, but I understand that by this term Mr. Blanford means "Y fellings," an interesting mixture of improvement fellings in favour of one particular age-class, regeneration fellings, and even the drastic fellings made by Taungya cutters. This peculiar type of felling is, however, of very recent origin and had not been invented at the time of the Conference.

The natural meaning of the word "concentrated" is the avoidance of diffusion of work, but I understand that Mr. Blanford interprets it to mean the restricting of work to one sub-periodic block during a period of 25 or 30 years.

By "repeated" I understand that Mr. Blanford means never repeated but followed up during the next few years by subsidiary cleanings.

Although the question of the Uniform system was not under consideration, the context to some extent bears out Mr. Blanford's interpretation. The discussion, however, was so vague and indefinite that it is extremely doubtful whether the majority of forest officers understood this resolution to mean the adoption of a hybrid Uniform system, and I am strengthened in this opinion by finding that Mr. Blanford himself opposed the resolution on the grounds that he considered the Selection system unsuitable for teak.

Mr. Blanford evidently desires one particular method of treatment to be steadily adhered to during the next 150 years, and at the end of that period the gradual conversion of our forests to

be carried out for the next 150 years. If he cannot be certain that the present *generation clearly understand and unanimously* support his proposals, he has still less security that our great grandchildren and their descendants will carry out the share of work which he has allotted to them.

It is essential for Mr. Blanford's purpose that his views should become the settled policy of the department, and the fact that the Conservators have drawn up standing orders for " Y fellings " may satisfy him that such will be the case. However, even during the short time that I have been in the country, the policy of the department has entirely changed. When I first joined, fire-protection and plantations were all the rage. The then Inspector-General urged that fire-protection should be extended so far as considerations of funds and staff allowed, and shortly afterwards the Local Government sanctioned a scheme to extend fire-protection to all teak forests in Burma within a period of five years. It was my privilege to assist in preparing such a scheme for my sub division but since those days the policy has undergone a considerable change. As regards plantations the formation of new plantations was entirely stopped by the Local Government for several years. A Conservator under whom I served as personal assistant frequently discussed with other officers the desirability of creating uniform woods. He submitted proposals to that effect to the Local Government, but in no quarter was there any indication that in a few years his views would become so fashionable. I have myself always considered the seedling class to be the least important, but when it was proved, and admitted by the Local Government, that fire-protection exercised a prejudicial effect on regeneration, I *repeatedly pointed out that this must ultimately have an adverse* effect on the yield. No one, however, seemed to take the matter seriously or to take any interest in reproduction. Now however a reaction seems to have set in. The scheme put forward at the Conference contemplated covering whole compartments with new regeneration. Mr. Blanford's intermediate method of treatment involves devoting the whole of our energies to reproduction. Y fellings have been proposed for a similar purpose. There are

already indications that after the prolonged slump in plantations there will shortly be a pronounced boom. Dibblings are again coming into favour, and, in fact, at present there seems to be a perfect craze for reproduction.

I regard this, however, as merely a passing phase. When a large number of our working-plans expire, it seems to me inevitable that there will be a serious decrease in the yield. In many cases the surplus of overmature trees will have been removed with the result that the number of trees available for girdling will be reduced and what is more important that the average volume per tree will be considerably smaller. I anticipate therefore that there will be another violent reaction in favour of the middle-aged classes of teak.

So far as I can judge, therefore, we have not got a settled policy, nor do I think we are likely to have one until more attention is paid to financial results. But without a settled policy it seems impossible to bring such a scheme as Mr. Blanford's to a successful conclusion.

If his scheme were inherently sound there might still be a sporting chance. In calculating the financial possibilities, however, I cannot do better than accept Mr. Blanford's own estimate. The conclusion he has apparently arrived at is that it is doubtful whether at the end of 150 years his method of treatment will yield such satisfactory results as would be obtained were he to leave the jungle to Nature. The general expenditure of the department is increasing rapidly. Divisions are being split up, establishments increased, and it seems pretty certain that at the end of 150 years, not only will he have obtained no interest on his outlay, but that his nett surplus will have fallen considerably. He points out quite rightly that his financial results would be far better than those obtained under a system of immediate conversion, but if he wishes to gain a true perspective, he should compare his results with what could be attained under a system of sound management. He must be aware that elsewhere thinnings are not restricted to even-aged woods and plantations, but that in all other countries where a staff of trained forest officers is maintained, it is attempted—and more

especially in mixed woods—to give every tree which it is desired to bring into the final crop adequate room for proper development. He must realise that annually hundreds and thousands of immature teak trees, saplings, and seedlings are killed owing to supression by utterly worthless species. He must have noticed that seedlings are more numerous than saplings and saplings than larger trees, and if he has studied the natural rate of increase of teak, he must, I think, admit that by carrying out systematic improvement fellings in order to give teak and other species of marketable value sufficient room for development he would reduce deformity, accelerate the rate of growth, and by reducing the mortality ensure a steadily increasing yield and at the end of 150 years might not improbably quadruple the outturn of teak.

There are forests in Burma where we should be perfectly justified in adopting the Uniform system. "Indaing" forests are usually homogeneous, and the "In" tree (*Dipterocarpus turberculatus*) is exceptionally suited for conversion into even-aged woods. Again we have a few reserves on excellent paddy land in the vicinity of large towns or villages and in these an intensive method of treatment would be justified. But our teak forests are another matter. It is natural that we should have a predilection for the type of forests in which we passed our course of practical training, but I would deprecate an abject and unintelligent imitation of these forests. By all means let us postpone the actual conversion of these forests for 150 years, but if in the meantime we are to carry out work merely for the purpose of facilitating conversion, let us do so for sound and well-proved reasons, and not merely because in Germany the forests are uniform and even-aged

IDENTIFICATION OF THE WOOD OF INDIAN JUNIPERS.

BY W. RUSHTON, A.R C S., D.I.C.

The woods of the Indian species of *Juniperus*, *J. recurva*, Ham., (*J. Wallichiana*), Hook. and Thom. (*J., pseudo sabina*, Fisch. and Mey), *J. macropoda*, Boiss, (*J. excelsa*, Brandis non Bieb), and *J. communis*, Linn., have characters similar to those of other species of *Juniperus* which generally have narrow sinuous annual rings with the summer-wood usually thin but dense. Resin-cells are present but resin-ducts are absent.

The Indian species can be readily distinguished by observation of the structural features indicated in the appended table.

It will be noticed that the following features are diagnostic of the several species : –

J. recurva -Shallow medullary rays, slit-like apertures to the bordered pits scattered arrangement of the resin-cells.

J. Wallichiana—Large size of the resin-cells.

J. macropoda—Restriction of the resin-cells to the outermost part of the annual ring and the small size of the resin-cells.

J. communis—Lack of all features above given, and exclusion of the resin-cells from a considerable part of the outer region of the annual ring.

A full account of the wood of Indian species of *Juniperus* can be found in my paper in the Linnean Society's Journal Vol. xliii, 1915.

		J. recurva.	*J. Wallichiana.*	*J. communis.*	*J. macropoda.*
Annual rings.	Number of rings per inch of radius.	44	26	33	42
Medullary rays.	Tangential height.	1—8 cells.	1—18 cells.	1—20 cells.	1—18 cells.
	Shape of pits on the radial lateral walls.	Orifice small and slit-like extending beyond the round border.	Orifice oval occasionally extending beyond the round border.	Orifice oval and never extending beyond the round border.	Orifice oval hardly ever extending beyond the border.
Tracheids (Bordered pits)	Number of pits on the radial walls.	Not numerous	Fairly numerous	Not numerous	Very numerous often touching each other and round to elliptical in shape.
Resin cells ..	Arrangement in the annual ring as seen in transverse section.	Somewhat *scattered* in the middle of the ring and extending outwards to the *third* row of tracheids from the outer limit of the annual ring.	Zonate. Occupying a position between the middle of the annual ring and the *fourth peripheral* row of tracheids from the outer limit of the annual ring.	Zonate. Occupying the middle of the ring up to the *twentieth* row of tracheids from the outer limit of the annual ring.	Zonate. *Occurring in a tangential zone up to the limit of the year's* growth, *i.e.*, always in the summer wood and never more than the sixth tangential row of tracheids from the outer limit of the annual ring.
	Length in longitudinal section.	185µ ...	230µ ...	125—200µ ..	65—88µ
	Radial width ...	12—15µ ...	27µ ...	12·5—15µ ...	3—5µ

NOTE ON A FIELD TEST FOR THE DETECTION OF PARAFFIN ADULTERATION IN BEES-WAX.

BY T. P. GHOSE, B.SC., ASSISTANT TO THE CHEMICAL ADVISER, DEHRA DUN.

Correspondence has been going on for some time between the Chemical Adviser and Mr. Strickland, Agent to the Mysore Government, Shimoga, to find out a speedy field test for quantitative detection of paraffin adulteration in bees-wax. Mr. Strickland in one of his letters observes that a good deal of the Indian trade in bees-wax is being lost on account of its heavy and unscrupulous adulteration with paraffin wax. Unless some speedy method is found to detect adulteration and efforts are made to export pure bees-wax from this country, it is likely that the trade in this article will be entirely lost.

The only constant which is likely to give some evidence as to the extent of adulteration of pure wax with paraffin without the help of a chemist is specific gravity. A suggestion is also made in Lewkowitsch's *Chemical Technology and Analysis of Oils and Fats and Waxes* that specific gravity gives some information as to the purity of wax. It must, however, be borne in mind that a chemical analysis alone can give definite information as to the nature and extent of adulteration.

The ordinary adulterants of bees-wax are—(i) Tallow, (ii) Mineral wax or paraffin, (iii) Ant or drone wax. But it is seldom that the trader mixes fats or ant-wax with genuine wax as both of these affect the odour and consistency of the wax and the purchaser of experience recognises such adulteration by the feel. This, however, it is difficult to do when paraffin is used as the adulterant. Hence it is mainly the adulteration with mineral wax that is discussed here, and detection depends upon determination of the specific gravity.

It was reported by Mr. Strickland that there was some difficulty in making speedy specific gravity determinations of commercial samples of bees-wax. He tried the floatation method. It consists in dropping small pieces of wax in different mixtures of alcohol and water, the specific gravity of the wax being the

same as that of the alcohol mixture in which it floats. But this method was not very successful as it was difficult to obtain uniform blocks of wax totally free from air. The only rapid way to make a number of specific gravity determinations with accuracy seemed to be in using wax in the melted condition. Apparently the use of the hydrometer would be too rough a test, while that of the piknometer or specific gravity bottle method would be too elaborate. It was therefore decided to use Westphal's specific gravity balance with solid glass plummet. (*Griffin's Chemical Handicraft, 9th edition, Catalogue*, page 120, No. p. 5622 c.) The specific gravities of a number of mixtures of pure yellow bees-wax and paraffin were tested by this balance and the results obtained are tabulated below :—

Pure wax.		Paraffin wax.	Specific gravity at 95°C.
100	..	..	0·846
95	...	5	0·845
90	...	10	0·841
80		20	0·830
66·6	.	33·4	0·825
50	..	50	0·810
33·4	...	66·6	0·801
10	...	90	0·790
...	...	100	0·785

The method of determination is as follows :—

The plummet is first dipped in distilled water at the temperature of the room and the upward buoyancy counterbalanced by means of the riders. The sample of wax to be examined is then melted and strained through cloth into a long boiling test tube wide enough to receive the plummet. It is then put into a tall beaker containing water and fitted with a cork having two holes; through one of these a bent tube is put in to carry off the steam and into the other the tube holding the sample is fitted. Water

in the beaker is boiled and the temperature of the wax is noted till it is constant. The plummet is then put into the wax and the upward buoyancy is counterbalanced by means of the riders. The reading for the distilled water at room temperature has to be converted into that at the temperature of the melted wax, this can be done by using the following formula :

$$R^1 = R\,\frac{D^1}{D}$$

R^1 = the required reading for water at the temperature of melted wax.

R = reading for water at the room temperature.

D^1 = density of water at the temperature of melted wax.

D = density of water at the room temperature.

The reading in the case of wax is to be divided by the reading in the case of water calculated to the wax temperature, in order to get the specific gravity of wax at the temperature of the melted wax.

For example :—

The plummet put in distilled water at 28°C (the room temperature) required 0·940 grms. to counterbalance the upward thrust.

The plummet when dipped in melted wax (at 95°C) *required 0·770 grms.*

The density of water at 95°C is 0·962.

The density of water at 28°C is 0·996.

Hence the reading for water at 95°C $= \frac{·940 \times ·962}{·996} = 0·908$

$\therefore$ the specific gravity of wax at 95°C is ·770/·908 = ·846.

The table given above was obtained by determining the specific gravity of a mixture of genuine yellow bees-wax and pure white paraffin wax. But similar tables of reference can be prepared by local purchasers themselves for different kinds of bees-wax and paraffin wax.

A table giving the densities of water at different temperatures is appended below for facility of reference :—

Temperature.		Density (*in vacuo*), *i.e.*, weight of 1. c.c. water in grms.	Temperature.		Density (*in vacuo*), *i.e.*, weight of 1. c.c. water in grms.
0°C	.	0·9998	23°C		0·9976
4°C	..	1·0000	24°C	..	0·9974
6°C	...	0·9999	25°C	..	0·9971
8°C	...	0·9998	30°C	..	0·9958
10°C	.	0·9997	35°C	...	0·9942
12°C	.	0·9995	40°C	...	0·9924
13°C	..	0·9994	45°C	...	0·9904
14°C	..	0·9993	50°C	..	0·9882
15°C	..	0·9992	55°C	...	0·9858
16°C	...	0·9990	60°C	...	0·9833
17°C	..	0·9988	65°C	..	0·9807
18°C	..	0·9987	70°C	..	0·9779
19°C	..	0·9985	75°C	.	0·9749
20°C	..	0·9983	80°C		0·9719
21°C	.	0·9981	85°C	.	0·9687
22°C	..	0·9978	90°C	.	0·9655
			95°C	.	0·9621
			100°C	.	0·9586

AMBROSIA BEETLES OR PIN-HOLE AND SHOT-HOLE BORERS.

(COL., FAM., *IPIDÆ, PLATYPODIDÆ.*)

BY C. F. C. BEESON, FOREST ZOOLOGIST.

A class of insect-injury, that is very characteristic of Indian forests, is due to certain beetles known by the term "ambrosia beetles," and belonging to the two families *Ipidæ* and *Platypodidæ*, which until recently were combined under the more familiar name of *Scolytidæ*. The course of study in forest entomology, which is followed in most European centres of instruction in Forestry, deals

with only a part of the family *Scolytidæ* (*i.e.*, superfamily *Scolytoidea*), the bark-beetles proper, or *Ipidæ*, while the *Platypodidæ* are rarely referred to, chiefly for the reason that only two species of the latter family occur in Europe. In India and Burma, on the other hand, the *Platypodidæ* are richly represented in the insect fauna of the forests of both countries, a fact which raises the importance of the family to tropical sylviculture, to the high degree attained by the *Ipidæ* in forests of temperate regions. The same may be said of the genus *Xyleborus*, which comprises those beetles of the family *Ipidæ*, which have habits similar to the *Platypodidæ*.

Mr. E. P. Stebbing was the first to draw attention to the economic importance of these groups, and his recent work on forest Coleoptera records many of the species of ambrosia beetles found in India. The present writer is engaged in preparing an account of those species which affect the Sal (*Shorea robusta*), and hopes to enlist the assistance of officers in the principal Sal divisions of the United Provinces, Central Provinces, Bengal, Assam, Bihar and Orissa in the collection of specimens. (Forest Zoologist's Circular No. 547/108-16, dated the 28th September 1915.) The main object of this note is to offer a brief description of the habits of the more important species and the type of damage produced by them, in the hope that other Forest Officers will collect and send in specimens of species occurring in the principal timber trees of their divisions.

Ambrosia beetles.

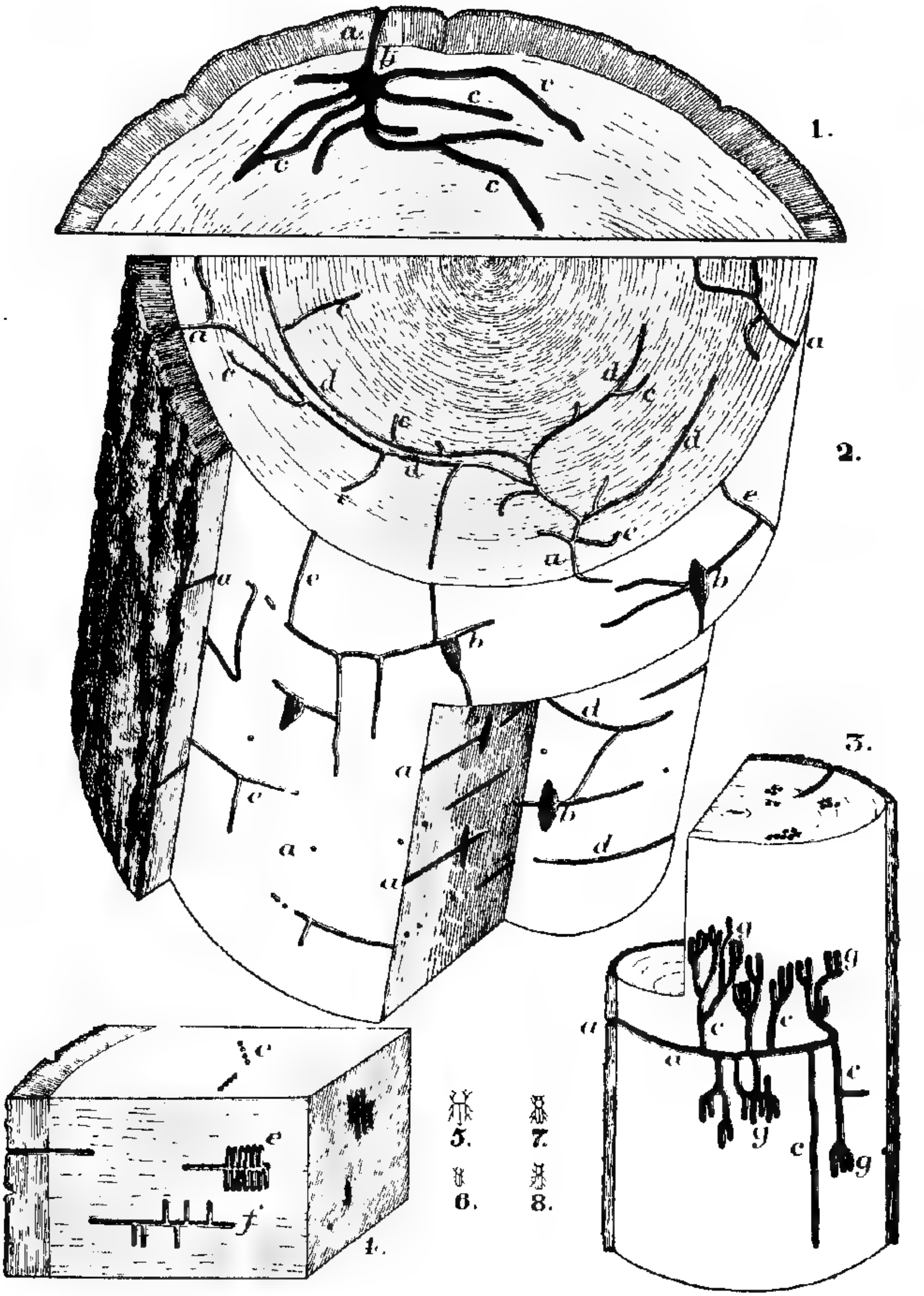
Ambrosia beetles are small cylindrical insects varying in length from 1·5 mm. to 8 mm. They owe their name to the fact that the majority of them live in the larval stages on a fungus, the ambrosia, which grows on the walls of the galleries bored in the wood of green trees by the parent beetles. Unlike other timber borers the larvæ do not feed on the bark or wood tissues excavated during the formation of the galleries, nor do they take an active part in the construction of the tunnels and chambers in which the immature stages of their lives are passed. The boring of the galleries is carried out entirely by the mature parent beetles of which the female almost invariably undertakes the initial and subsequently the major part of the work.

The food fungus.

The ambrosia appears as a glistening white layer lining the walls of some of the galleries, and under magnification is seen to consist of a net work of hyphæ and irregular masses of conidia. Several species of ambrosia fungi are known and are apparently definitely associated with certain species or groups of species of beetles. The mode of origin and development of the food fungus is imperfectly known, but the spores are transported from one host tree to another intentionally or accidentally by the parent beetle. In the case of a European species (*Xyleborus dispar*, Fab.), the spores are carried in the crop of the beetle and subsequently regurgitated; in the case of some Indian species a group of pores on the dorsal surface of the thorax functions in the transport of the fungus. The ambrosia grows in the newer and fresher branches of the system of galleries, and is sometimes accompanied by a bluish or black staining of the wood tissues immediately surrounding the galleries. In the tunnels of many species of shot-hole borers, especially Platypodids, the ambrosia is reduced to a very fine and almost imperceptible layer and evidently forms only a portion of the food-material, which is mainly composed of sap.

Conditions of attack.

The trees selected by the migrating swarms of beetles are usually those which are dying or very much weakened as a result of the attack of primary insects, fungal disease, unfavourable local conditions, etc.; freshly felled trees offer the most suitable conditions for the successful development of a brood, as they possess an abundant supply of fresh sapwood without the resistant powers of a living tree. Moist sap-bearing tissue in which the process of decomposition proceeds with normal speed, appears to be a necessary condition to the beetle. Vigorous living trees are rarely attacked and still more exceptionally killed outright; on the other hand very few species attack barked or partially seasoned unbarked logs, and dry timber is immune. These remarks apply to forest trees in which heartwood has appeared, but cases of directly fatal injury by ambrosia beetles occur to living tea, coffee, camphor, pomaceous and citrus fruit trees, etc.



GALLERIES OF AMBROSIA BEETLES.

No. 4245-785.

Gallery-patterns.

The injury due to ambrosia beetles consists of shot-holes, pin-holes and stained-wood defects in the sapwood and outer heartwood of timber, hence the origin of the terms shot-hole and pin-hole borers.* The size of the holes which appear in transverse or tangential section in dressed timber, corresponds to the size of the beetle producing the hole, and varies in diameter from ·5 mm. (pin-holes) to 3·0 mm. (shot-holes). The patterns of the galleries made by the different species vary considerably, but are rarely seen in entirety in ordinary conversion operations. We have, however, worked out with chisel and fret-saw the gallery-patterns of several species of Indian *Ipidæ* and *Platypodidæ* and find them to be assignable to three general types.

In Type I the internal galleries are arranged in a group of short branches confined to a horizontal plane with an irregular chamber at the nexus.

In Type II the system is more extensive and consists of a series of main galleries running parallel to the circumference of the bole in a horizontal plane with numerous short offsets or branches.

In Type III the main gallery-system lies in vertical planes.†

As an example of the first type may be taken that of *Xyleborus major*, Steb. (Ipidæ), which is illustrated half natural size in Plate 16, fig. 1.

Type I—*Xyleborus major.*

The mature female beetle (fig. 5, natural size) bores an entrance tunnel (fig. 1*a*) horizontally and more or less directly through the bark into the sapwood of the Sal, which is its principal host-tree. The entrance tunnel terminates at a depth of ½ to 1 inch in an irregular chamber (fig. 1*b*) which is excavated vertically and horizontally for a few beetle-lengths. Taking off from this chamber is a number of short branches (fig. 1*cc*), which extend more or less fan-wise, but may

* The term shot-hole borer is also applied to beetles of the family *Bostrichidæ* but they are exclusively dry wood borers and do not feed on ambrosia.

† In the description of the gallery-patterns the terms horizontal and vertical should be taken to mean at right angles and parallel respectively to the central axis of the bole, and thus apply equally to a standing or recumbent tree.

anastomose, or be prolonged irregularly in a circumferential direction. The walls of the gallery are black in colour, with a conspicuous layer of glistening white ambrosia fungus lining the walls of most of the terminal branches. The female of this species of *Xyleborus* is fertilised by the male before the migratory flight cocurs, and is ready to lay eggs as soon as the excavation of the galleries is well under way. The eggs are usually laid at the ends of the branch galleries in groups of 3 to 6 and are left to hatch while the extension of the galleries is continued by the female. The excavation of the galleries, the laying of eggs and the rearing of larvæ go on synchronously as long as the wood remains in a condition favourable for the maintenance of the food-supply. The larvæ, as soon as they hatch, wander freely about the tunnels, feeding on the fungus and sap exudation. On becoming full-fed the larvæ are ready to pupate and may do so at the ends of the lateral galleries or in the central chamber. After a short pupal period the change to the imaginal form takes place, but the beetle matures relatively slowly. Its skin is at first soft and white but hardens and deepens in colour while the beetle feeds in the galleries in company with the larvæ. A very high proportion of the beetles are females; usually one or two only of the progeny of the mother beetle are males. *It is presumed that the polygamous males* fertilise their brood-sisters and do not take part in the subsequent swarming. Galleries on the above pattern are constructed by *Xyleborus semigranosus*, Bldfd., *Xyleborus fornicatus*, Eichh., *Eccoptopterus sex-spinosus*, Motsch. (Ipidæ).

Type II – *Xyleborus fallax*.

The pattern of the gallery-system characteristic of the second type is more elaborate than that of Type I, Plate 16, fig. 2 (half natural size) shows the galleries of *Xyleborus fallax*, Eichh. The entrance tunnel (fig. 2*a*) runs horizontally and radially into the sapwood to a depth of 1 to 2 inches from the external surface. The main gallery (fig. 2*d*) then curves sharply to the right or left and follows the incremental zones of the sapwood, more or less truly concentrically for a variable distance which may eventually extend to 8 or 9 inches. From the main galleries numerous short branch galleries

(fig. 2*c*) take off in the sapwood and heartwood, and are usually occupied by eggs or larvæ. The larvæ are free to wander throughout the chain of galleries in search of new-grown ambrosia, and are to be found as frequently in the older black stained tunnels as in the newly-bored portions. The full-grown larvæ may pupate at the ends of the lateral galleries but more commonly in small vertical chambers of irregular triangular shape (fig. 2*b*) which occur at intervals on the main and branch galleries and also (in the case of *Xyleborus fallax*) on the external surface of the sapwood. The development of the immature beetles and the remainder of the life cycle is similar to that of *Xyleborus major* already described.

This type of gallery-pattern is subject to several modifications chiefly in the presence or absence of brood-chambers and external connecting galleries (fig. 2*c*) and in the form of the pupal chamber. Galleries of a slightly modified type are made by *Xyleborus perforans*, Wall., *Xyleborus andrewesi*, Bldfd., *Xyleborus parvulus*, Eichh., *Xyleborus submarginatus*, Bldfd., *Xyleborus laticollis*, Bldfd.

The *Platypodidæ* also exhibit modifications of the second type, which are developed most typically in the genera *Platypus* and *Diapus*. The principal characteristic of the Platypodid gallery in which it differs from the example described, lies in the shape and arrangement of the pupal chambers. In the case of *Diapus*, *e.g.*, *Diapus furtivus*, Samps., *Diapus impressus*, Jans., the individual larvæ pupate each in a separate chamber, which is excavated vertically above and below short branch galleries in close groups of 6 or 7 like the teeth of a double comb (fig. 4*e*). In the case of *Platypus*, *e.g.*, *Platypus solidus*, Chap., *Platypus curtus*, Chap., *Platypus biformis*, Chap., the pupal chambers are constructed on the same plan but are arranged at irregular intervals on the main and branch galleries (fig. 4*f*).

Type III—*Crossotarsus saundersi.*

The gallery-pattern of class III is very sharply contrasted with that of the two previous types and has been found up to the present only in the genus *Crossotarsus*, Platypodidæ, *e.g.*, *Crossotarsus saundersi*, Chap., *Crossotarsus squmulatus*, Chap., *Crossotarsus bonvouloiri*, Chap., *Crossotarsus coniferæ*, Steb.

The main entrance gallery of *Crossotarsus saundersi* (Plate 16, fig. 3*a*) runs radially and horizontally into the heartwood of the host-tree to a depth of 2 to 4 inches, and may bifurcate at the extremity, but usually remains single. Taking off at intervals above and below the main horizontal galleries is a series of successively constructed vertical galleries (fig. 3*c*), which expand each into a group of secondary branches after the fashion of a candelabrum. The individual branches of the group terminate in vertical cells, which are eventually used as pupal chambers (fig. 3*g*). The cells of each group are closely in contact so that the whole system is more or less approximated into one vertical plane. The walls of the galleries are black and this colour also stains the surrounding wood. A layer of ambrosia lines the walls of the more recent galleries and is succeeded by a layer of organic matter of waxy consistency in the later stages of the evolution of the galleries. Eggs, larvæ and immature beetles are found in all parts of the system, but the pupæ are confined to the terminal cells at the ends of the branch galleries, and enclosed by a thin partition of wood-dust and wax.

As in most species of *Platypodidæ* the original pair of beetles lives on and brings up the brood. The female is to be found somewhere in the internal galleries laying eggs, and excavating fresh branches and maintaining the development of the ambrosia. The male is almost invariably to be found blocking with his body the entrance tunnel in the bark, only leaving this post to feed and to assist in the removal of excrement and débris from within.

Characteristics of attack.

A log infested with shot-hole and pin-hole borers if examined during the course of the attack will exhibit the following characteristics. The bark shows numerous small shot-holes from which short cylinders of compacted wood-dust protrude or have fallen. Stripping off the bark may reveal a few male beetles in the entrance hole, but a wedge cut 3 or 4 inches deep into the heartwood so as to expose the internal galleries on a transverse section discloses eggs, young and old larvæ and immature beetles in the galleries and pupæ in the pupal cells and brood-chambers. These conditions may obtain

during a period of 2 to 5 months, depending on the rate at which the wood dries and the species of borer attacking it.

Below is given a list of the identified species of shot-hole and pin-hole borers which have been found attacking the Sal :—

Ipidæ.	*Platypodidæ.*
Xyleborus andrewesi, Bldfd.	*Crossotarsus bonvouloiri*, Chap.
„ *aplanatus*, Wich.	„ *saundersi*, Chap.
„ *fallax*, Eichh.	
„ *laticollis*, Bldfd.	
„ *major*, Steb.	*Diapus furtivus*, Samps.
„ *parvulus*, Eichh.	„ *quinquespinatus*, Chap.
„ *perforans*, Woll.	*Platypus cavus*, Stroh.
„ *schlichii*, Steb.	„ *cupulatus*, Chap.
„ *semigranosus*, Bldfd.	„ *curtus*, Chap.
„ *submarginatus*, Bldfd.	„ *solidus*, Chap.
Eccoptopterus sex-spinosus, Motsch.	„ *pilifrons*, Chap. ♀.

DESCRIPTION OF PLATE (No. 16).

Fig. 1. Gallery system of *Xyleborus major*, Steb. (half natural size).
2. „ „ *Xyleborus fallax*, Eichh. („ „).
3. „ „ *Crossotarsus saundersi*, Chap. („ „).
4. Pupal chambers of *Diapus furtivus*, Samps. and *Platypus solidus*, Chap. („ „).
5. Female beetle of *Xyleborus major*, Steb. (natural size).
6. „ „ *Xyleborus fallax*, Eichh. („ „).
7. Male beetle of *Crossotarsus saundersi*, Chap. („ „).
8. Female beetle of *Diapus furtivus*, Samps. („ „).

Legend in all figures –

a. entrance tunnel.
b. brood-chamber.
c. branch galleries.
d. main galleries.
e. pupal chambers (*Diapus*).
f. pupal chambers (*Platypus*).
g. pupal chambers (*Crossotarsus*).

TREWHELLA MONKEY WINCH IN FOREST WORKS.

BY K. GOVINDA MENON, CONSERVATOR OF FORESTS, COCHIN STATE.

Mechanical appliances in forest works are always a source of great saving of time and money. In India application of such appliances is very limited. Felling is usually done by human labour and collection to carting or floating sites by elephant, bullock or buffalo and human labour. These agencies, it must be admitted by people of experience, are not of a time and money-saving nature. Anything, therefore, which could be profitably used to minimise waste of time and money deserves our serious consideration.

The Monkey Winch of these notes is largely used in Australia to pull down trees, to grub out stumps and to clear felled areas for settlement. Its power is enormous and its working very cheap and simple. Two good workmen can handle it easily. A short description of it is subjoined:—

It consists mainly of a Cog wheel of about 10′ diameter fitted in a frame and with brake. The axle of the Cog-wheel, called the drum, has one end of a steel rope fixed into it permanently. The other end with a patent hook will be attached to the object to be pulled out or hauled up. This rope, when the winch is worked, winds round the drum. At the narrow end of the winch frame is a ring to which would be attached, when the winch is worked, the Anchor-rope; the other end of the Anchor-rope will be attached to something which is firmly fixed to the ground. A tree or a stump will answer the purpose well. The machinery is mounted on two small wheels to facilitate removal from place to place.

Plates 17 and 18 show the machinery as well as its method of working. The Snatch block is used when the object to be pulled up weighs more than 12 tons. With the Snatch block the winch pulls up 24 tons easily. The Grab is used to grub out stumps. The winch can easily pull up the maximum weight of 24 tons on a grade of 1 in 3. The distance of the object pulled up depends, of course, on the length of the rope used.

The winch with all its accessories can be had of Messrs. Pierce, Leslie and Co., Ltd., Cochin or Calicut, for about £28.

THE TREWHELLA MONKEY WINCH.

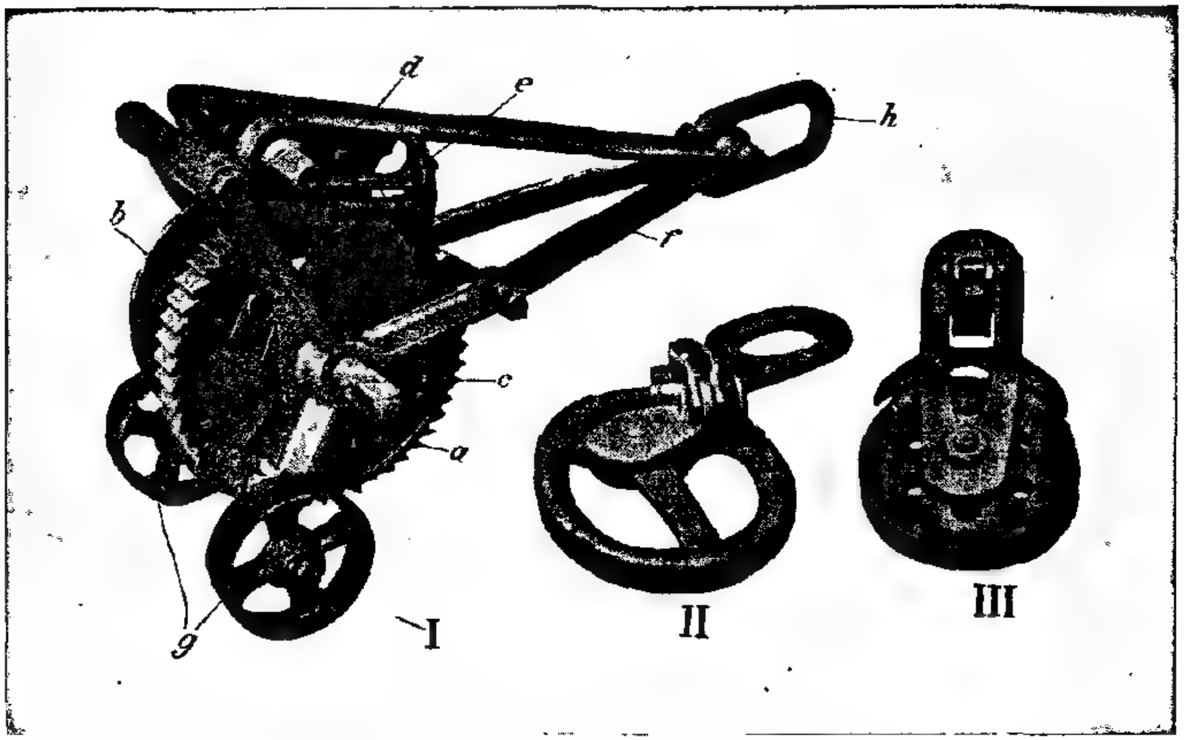


Photo-engraved & printed at the Photo.-Mech. & Litho. Dept., Thomason College, Roorkee.

I. Winch. Its parts are:— a. Cog-wheel. b. Drum. c. d. Axle-ends to fit in the lever to work the winch. e. Brake. f. Frame. g. Wheels. h. Ring to which the anchor-rope will be attached.

II. Grab.

III. Snatch-block.

THE TREWHELLA MONKEY WINCH PULLING A TEAK LOG OF 148 CUBIC FEET ON LEVEL GROUND

My cordial thanks are due to Mr. C. E. C. Fischer, of Coimbatore Forest College, who had informed me of the existence of the winch and who had also asked me to write a few lines on it and its working to the *Indian Forester*.

PRIZE ESSAY.

The following essay gained the prize at the Coimbatore Forest College open to its students and has been sent to us for publication:—

ADVANTAGES AND DISADVANTAGES OF A PURE FOREST COMPARED WITH A MIXED FOREST FROM THE POINT OF VIEW OF TIMBER TRADE AND GENERAL SYLVICULTURAL TREATMENT.

Pure crops are seldom found in nature, and in South India at any rate, almost all such crops are those raised in plantations. The natural forests consist of large numbers of more or less unmarketable species with a smaller proportion of valuable ones scattered in between. The question of the relative advantages and disadvantages of pure crops as against mixed ones is only of academic interest in the treatment of natural forests, but is of the utmost importance when raising plantations. A thorough comprehension of the subject in all its bearings would, there is no doubt, have considerably modified the policy of Government in regard to the teak plantations of Nilambur.

It rarely happens that a soil is homogeneous in character throughout a forest area and different trees have different soil requirements. The stocking of an area with one species of tree alone might therefore result in the formation of blanks in places. In a mixed crop, if the soil is not suitable to one species, other trees might flourish there, and the whole area could thus be well stocked.

The different habits of trees in regard to their crown and root render the leaf canopy and utilisation of the ground complete in a mixed forest. Some trees have flat spreading crowns, others have narrow tapering ones. Between the two spreading crowns there is generally room for one or more narrow crowned trees, while another of the same species would be choked off. Then again, some trees are light-demanders, others can endure a considerable amount of shade. The two could be mixed with advantage to both. Light-demanders alone or shade bearers alone would not completely cover the ground. The complete utilisation of the air

space above is therefore possible only in a mixed forest. Similarly in the case of roots. Some are deep-rooted and others are shallow-rooted. These two sets of trees could live and thrive in the same area without one interfering with the other. Except in the case of a few alluvial soils as in Nilambur the complete covering of the soil is of the utmost importance in South India. In the almost pure forests of *Pterocarpus santalinus* of the Seshachallam hills, the existing growth is not sufficient to cover the ground effectively. The soil is therefore deteriorating in quality and we find that trees of large dimensions are simply *non est*. In the teak plantation of Nilambur (1855) where the soil was unsuitable to teak, *Xylia xylocarpa* introduced itself—an effect of nature to preserve the productivity of the soil intact. Nature knows best what tree-growth can be supported by a particular soil and it is seldom wise to improve upon her. Once tree-growth has been established—mixed as surely it will be—it is up to the sylviculturist to control the forest and make it suit his ends best.

In almost all pure forests such as the teak plantations of Nilambur or the *Casuarina* plantations of the East Coast, the soil is rich but toxic. Humus is decomposed with difficulty and fails therefore to enrich the soil or serve its purpose effectively. In Nilambur there is always a large quantity of leaf accumulation but it decomposes seldom and becomes acid. In the *Pinus longifolia* plantations of Coonoor the soil is covered with such a thick carpet of pine needles that there are no chances of the seed striking root. In the natural forests adjoining, the leaf accumulation rapidly decomposes and becomes converted into that most useful material humus. The material required by one tree is the same as that required by all other trees in a pure plantation, and there is therefore a gradual impoverishing of the soil in respect of such materials

In regard to natural regeneration the difference between the pure and the mixed forests makes itself apparent. In almost all pure crops such as the teak plantations of Nilambur regeneration is conspicuous only by its absence. Fruit is produced plentifully enough, even at an abnormally early age but the seeds fail to

germinate or germinating fail to establish themselves. In the older plantations where the canopy is considerably open on account of the removal of trees in thinning, there is a failure of reproduction. In a pure *Pterocarpus santalinus* forest of Cuddapah there is not too much cover overhead but there are no seedlings in places and the trees do not even fruit. In the same species planted in the Chittoor Reserve but mixed, there is plentiful regeneration. In the Tekkadi leased forests where there is a judicious mixture introduced, reproduction is not wanting and is even plentiful. In a pure crop especially if planted up close there is bound to be a congestion of the crowns and there is but little effective light admitted down below. In the case of mixed forests there is a regular gradation of crowns, albeit scattered, and while the soil is completely covered, there is enough light for the regeneration to spring up. Sylviculture fails in a forest with no natural regeneration and judged by this canon, pure forests fail.

In the pure forests of *Pterocarpus santalinus* and *Acacia arabica* the mean annual increment is small. In the *Eucalyptus* plantations of the Nilgiris the increment is as much as 1½ c. ft per acre per day. No doubt this large increment is due to the close plantation, (6 ft. × 6 ft.) method of treatment, being simple coppice on a ten years' rotation, and the particularly rich soil. The wood is used only for fuel, and this increment therefore does not come within our calculations. In the Muthinad plantation on the Nilgiris, where the *Eucalyptus Globulus*—a strong and durable wood in its natural habitat—has been planted (1881) and not been cut for fuel, the trees have reached very good dimensions, being now 27 feet 9 inches in girth and 90 to 120 feet in height. Fast-grown timber of this species in the Nilgiris has been found to be useless as it splits, warps, does not season properly and is not durable or strong. The increment does not leave anything to be desired, the trees are tall and cylindrical and were it not for the uselessness of the wood, the plantations would have been a success. In the teak plantations of Nilambur the mean annual increment is considerable and but for the epicormic branches that crop up on almost all the trees, their shape leaves nothing to be desired.

The strength of timber obtained from natural forests and from plantations differ as shown in Professor Everett's test in 1904. The following statement shows the breaking load on each kind of tree of the same dimensions, namely, 10′ × 5″ × 5″.

Place obtained from.	Breaking load in tons.
From the Prome plantation of 1861 ...	63·65
Do. do 1860 ..	63·50
Naturally grown teak, Burma .	75·68

This shows that naturally grown teak—and teak always grows in a mixed forest naturally—is much stronger than one grown in a pure crop. It is to be expected that a tree accustomed to life in a natural mixed forest should thrive better there, all qualities considered, than in an unnatural position as in a plantation. In the latter case, the texture of the wood is more open and the timber therefore is less durable. A judicious mixture of species and timely thinnings would produce excellent results in regard to height and girth increments while the quality of the timber would remain quite good.

It is well known that pure crops suffer more from external dangers such as wind, fire, insects, fungi, etc., than mixed crops. One seldom sees the great havoc done by caterpillars or borers in a mixed forest, but such form an every-day feature in the pure forests. Considerable damage continued to be done by caterpillars in the *Casuarina* plantations of South Arcot until they were mixed ; whole areas of pure teak in the Nilambur plantations are periodically attacked by *Hyblæa* and *Pyraustra* and defoliated. Different caterpillars fancy different trees, and an insect has not the same facility of spreading in a mixed forest as it has in a pure forest. Mixture of species is the only antidote known to fungoid attacks.

A mixed crop offers resistance to wind and is practically immune to that danger. The effects of wind on pure crops can be observed every day in the *Eucalyptus* plantations of the Nilgiris or

the teak plantations of Nilambur. Several stems are broken off and offer fertile breeding places for insects and fungi. In the cyclone of 1909, nearly 80 per cent. of the trees in a *Casuarina* plantation in the Ganjam District were broken off. A heavy cyclone does little mischief in a mixed forest and breaks off perhaps a couple of trees spread over several acres.

Ground fires are common enough phenomena in the South Indian forests, but fires of extreme violence are rare in a mixed forest. Most of the gregarious species are fire-hardy, and in the natural forest escape, but the plantations suffer heavily from violent fires. In South India crown fires are known only in the *Eucalyptus* plantations of the Nilgiris.

Frost, of rare occurence in South India, is known to damage the pure *Eucalyptus* plantations of the Nilgiris as evidenced by the large frost ribs in the trees of the Muthinad plantations. The sholas close by, containing as they do a mixed forest, escape damage. The keener struggle for existence in the pure even-aged forest renders the individuals therein less hardy to external dangers.

It is generally contended that a pure crop is easy to manage and does not present the same problems in regard to the unmarketable species always found in a mixed crop. The extraction and sale of the produce are easy enough, but, as pointed out above, it is difficult to regenerate a pure forest. In the mixed forest there are perhaps a couple of principal species with several auxiliary and accessory species, and unless suitably treated the principal species stand a chance of being ousted by the inferior ones. If the soil in the pure forest has not been rendered toxic—a rare contingency—it would be easy to regenerate it during the preparatory and final fellings. In a pure forest, at a time when the soil has to be rendered fit for receiving seeds, the canopy is opened by thinnings and the soil exposed. Regeneration therefore is particularly difficult and costly. Not so in the mixed irregular forests where regeneration is always going on and soil always covered. By careful handling, therefore, the sylviculturist can regenerate both classes of forests.

"The more scientfic methods of treatment cannot be applied to a mixed crop on account of the unmarketable species." This is a common argument against a mixed forest as if the method of treatment and not the product of timber is what the forester is primarily concerned about. Furthermore, the time is fast approaching when timber of whatever kind, be its durability, specific gravity, and transverse strength what they may, will find a ready sale for the manufacture of wood-pulp, acetone, etc. It follows also that a mixed crop would be able to meet demands for all kinds of produce.

Timber of large dimensions fetches a better price *ceteris paribus* than the same species of timber of smaller dimensions per unit of volume. More scantlings could be made out of a tall cylindrical tree than from a shorter more conical one, and in the former case there is less waste in conversion. The greater susceptibility to injury from external causes such as insects, wind, fire, etc., tend to create defects in the wood such as shakes in plantation-grown timber. In the efforts to get good-sized timber, the requisite qualities of strength and durability are sometimes lost sight of. The majority of traders are, however, satisfied about the quality of timber if of good dimensions, and therefore pay a better price for plantation-grown timber.

There is nothing to prevent the production of good-sized sound timber in mixed forest, as one finds in the *Hopea* and *Balanocarpus* forests of the Tinnevelly district, if properly treated. The quality of the wood grown in a mixed forest is unquestioned, and the largest demand is for sound scantlings of durable wood which the mixed forests can supply. The special demand for large-sized timber for masts of ships, etc., is necessarily limited, and for house and bridge construction all the largest beams and girders are replaced by steel beams. There should, therefore, be no particular demand for plantation-grown timber *ipso facto* and the produce of the mixed forest serving the purpose to which it is now ordinarily put finds a ready market and commands a fair price.

From the above remarks it will be seen that for protecting the soil, conserving its productive capacity, and getting the maximum

value out of it, for protection of the crop against external dangers such as wind, fire, insects and fungi and for securing natural regeneration, mixed forests are best suited, while for producing large-sized timber and facilitating the ordinary and less scientific methods of sylvicultural treatment applicable by the untrained staff available, a pure crop is indicated. The pure crop yields timber of great market value, in view of the special purposes to which such may be put, but the mixed crop yields a stronger and more durable wood which finds a ready market for the ordinary purposes to which timber is put and commands a good price.

"*Hoti*," let it be, the Grammarian said, but with foresters the subject will always be a

"VEXATA QUESTIO."

INDIAN TURPENTINE AND RESIN INDUSTRY.

Twenty-five years ago the Forest Department of the Government of India began experiments with the view of utilising the pine forests of Kumaon for the production of turpentine and resin. In 1896 resin-tapping operations were started in the Naini Tal Forest Division on a small scale ; a beginning was made with 10,000 trees, and a distillery was erected at Bhowali. The operations have since been continually and steadily extended, until in the year 1913-14, 670,000 trees were tapped and 43,000 maunds of crude resin collected. During 1914-15, 800,000 trees were to be worked and the estimated yield was 56,000 maunds of crude resin. The method of tapping adopted is to work a forest for five years and then give it a ten-year rest, and again work it for five years, and so on. It has been established that such tapping operations do no harm to the standing trees or to the forest. The method of extracting resin from the pine trees adopted in Kumaon closely resembles the French "cup and lip" method. A Forest Bulletin (No. 26) issued by the Government of India, and entitled *The Resin Industry of Kumaon,* by Mr. E. A. Smythies, describes in detail the method of tapping and collection of the crude resin, the purification of the crude resin in the distillery, the distillation of the resin, and the purifying and packing of the turpentine and resin.

A uniform standard of turpentine and resin is now turned out which is suitable for the most exacting requirements of Indian consumers, and, simultaneously with this, the tapping operations are being developed as rapidly as possible. The annual imports of turpentine and resin into India have averaged during the last five years 227,000 gallons of turpentine and 58,600 cwts. of resin. It is anticipated that the Bhowali distillery alone will in three years' time be in a position to supply about 60 per cent of the total consumption of turpentine and well over 80 per cent. of the resin consumption of India. But, in addition to the Bhowali distillery, the Forest Department will shortly be erecting another distillery in Eastern Kumaon, near Tanakpur, from which an approximate annual output of 25,000 gallons of turpentine may be expected,

while the departmental operations in the Punjab will ultimately give a further 50,000 gallons, making the total output of Indian turpentine equal to 200,000 gallons per annum and of resin 120,000 maunds. This will absorb practically all the workable forests of Chir Pine (*Pinus longifolia*) under the Forest Department.

Although the total imports of turpentine given above are rather over this figure, they include adulterated turpentines and substitutes, and the imports of pure turpentine are appreciably less. It is, therefore, not improbable that a certain amount will be available for export. It is pointed out, however, that there is no possibility of export to England or Europe, the natural outlet for any balance, after meeting Indian requirements, being to Australia, New Zealand, Java, etc. It is also possible that consumption in India will increase to an extent which will absorb the maximum output of the Indian distilleries, especially as a plentiful supply of raw materials should stimulate paint and varnish-making and kindred industries.—[*The Indian Textile Journal.*]

A POSSIBLE CAUSE OF "SPIKE" IN SANDAL.

BY T. A. WHITEHEAD, I.F.S.

Sandal is a parasite, but it is dependent upon the foster-plants only for its supplies of water and salts. It itself performs the important functions of respiration, assimilation and transpiration. It absorbs carbon from the atmosphere from which it forms indiffusible carbo-hydrates and converts the latter into substances which are diffusible and which can be utilised by the plant as food. The most important carbo-hydrate is starch ($C_6 H_{10} O_5$). Starch is converted into soluble glucose ($C_6 H_{12} O_6$) by the influence of the enzyme diastase, but the conversion cannot be accomplished without water ($H_2 O$), and still more water is then necessary to dissolve the soluble glucose. In fact, without water there can be no life. The living portions of all organisms are permeated with water; it is only when in this condition that the vital processes can be carried on. A large amount of water is retained in the plant body for the maintenance of rigidity and enlargement of the organs, but a still larger quantity of the water taken up by the plant passes through the plant merely as a medium for the transport of nourishment. The cells of a plant, set apart for the storage of accumulated reserve material, may be full of starch, yet without water the plant cannot make use of it. The above remarks have been noted with a view to advance the theory that the cause of "spike" in sandal is due to a reduction in the supply of water.

To test this theory it is necessary to consider in detail the known facts and recorded observations in respect of "spike."

I.—KNOWN FACTS.

(*a*) *A "spiked" tree has never been known to recover.*—It is here necessary to consider the effect which a reduction in the quantity of water would have upon a growing sandal. The quantity of water may be reduced by the death of one or more of the foster plants or by the severance of one or more of its connections. When this takes place the water-supply to a portion of the plant is

cut off either partially or wholly, but the processes of respiration and assimilation in the affected portion continue for some time longer. The result is that the quantity of reserve material is increased. If the whole of the water-supply to the affected portion is cut off that portion withers and dies. If a partial supply is maintained the quantity of water is sufficient to convert only a fraction of the reserve material into nourishing substances. There is no longer any necessity for a large leaf surface, and the size of the leaves in the affected portion is reduced. Before this could come about the sandal's efforts to obtain more water by establishing fresh connections must have failed. It must have taxed the remaining foster-plants to their utmost capabilities and thereby stopped any further growth in them. It was then forced to reduce itself to a size which the utmost energy of the remaining foster-plants could support and this maximum amount of water and salts it would continue to exact. Growth in both parasite and foster-plants is now no longer possible. The group of plants is merely able to support itself in its reduced condition. In the meantime one or more of the remaining foster-plants have possibly been over-taxed and begin to wither, so that the evil once commenced with such severity as to show outward signs of it is liable to continue; but in any case recovery is not possible.

(*b*) *A tree is frequently attacked in one part but healthy in another.*—If the supply of water be reduced sufficiently this would be the natural result. Reference to this condition of a sandal has already been made under I (*a*)

(*c*) *Healthy young seedlings are frequently observed in areas which are badly diseased.*—This requires no comment.

(*d*) *If the roots of a "spiked tree get damaged, "spiked" root-suckers are produced.*—It has been ascertained that a "spiked" tree contains an abundance of the reserve material starch. One of the most important functions of leaves is the absorption of carbon and its subsequent conversion into reserve material. When the reserve material is already present there is no longer any necessity for a normal leaf surface and hence the root-suckers are produced with reduced leaves.

(*e*) *If a tree is dug out and root-suckers spring up they are "spiked" as a rule. A tree has however been observed and photographed which produced a healthy root-sucker on one side and a diseased sucker on the other.*—The healthy root sucker was apparently produced from one of the roots which were supporting the remains of the sandal tree before it was cut. The "spiked" root-sucker, for reasons already given under I (*d*), must have been produced from a root connected to a host which had already failed to meet the demands of the sandal tree. The root-suckers would be all spiked if the tree was on the point of death.

(*f*) *The degree of "spike" in a tree is the same throughout the tree, thus if a further portion of a badly diseased tree becomes "spiked" it will not go through the early stages of the "disease."*—As noted under I (*a*) the reduction in the supply of water has the effect of reducing the size of the leaves in the affected portion. If the water-supply be still further reduced so as to affect a further portion of the plant but at the same time not sufficient to cause the death of the portion originally affected, the water-supply to the old and newly affected portions will now be evenly distributed over the whole portion now affected, and the degree of spike will be the same throughout the affected portions.

(*g*) *The ends of the shoots die before the branches.* This would be the natural result of a reduction in the water-supply, as is seen in the case of trees that are withering.

II.—RECORDED OBSERVATIONS.

(*a*) *The "phyllode" in "spiked" trees is due to excess of starch in the stem, twigs and leaves.*—It has already been noted under I (*a*) that the reduction in the supply of water to any portion of the plant partially arrests the formation of soluble glucose from starch before the formation of starch by assimilation is likewise partially arrested. An excess quantity of reserve material is accumulated and the daily expenditure of starch is considerably reduced owing to the reduction in the supply of water. The functions of the leaves is curtailed, since the exposure of a large leaf surface to the light is no longer necessary, and their size is naturally reduced.

(*b*) *No fungus disease has been found and healthy trees could not be infected either with refuse of diseased trees or by budding.*—This requires no comment. It supports the theory that "spike" is not a disease.

(*c*) *In "spiked" trees the root ends die and the haustoria are either absent or dead.*—If the sandal over-taxes one or more of its foster-plants and finally kills them, or if they die naturally, the root ends and haustoria connected to these dead foster-plants would naturally die off. This is where the trouble begins. It is the severance of its connections with the foster-plants that causes "spike" in the sandal.

(*d*) *Apparently all roots of diseased trees were found to have scars from being parasited upon. This, however, is the case even with healthy trees. In one case a living haustorium was found on a "spiked" tree.*—A sandal which is itself parasited upon is liable to come to grief more readily than one which is free from such parasites. But there is no reason why a healthy sandal connected to powerful foster-plants should not be able to support parasites without detriment to itself.

III.—GENERAL.

(*a*) "*Spiked*" Zizyphus Œnoplia, Dodonæa viscosa *and* Pterolobium indicum *have been observed.*—A reduction in the supply of water to a foster-plant would have a similar effect upon it as it has upon the sandal. But the parasites which suck a foster-plant dry need not necessarily be sandal. In localities where sandal abounds it is likely to be the sandal. Mr. P. M. Lushington observes that he noticed "spike" *Zizyphus* in North Coimbatore as long ago as 1903. This is to be expected, since the effect of parasites upon small foster-plants would first be noticeable in the foster-plants which are being sucked dry by parasites, and the result of the death of the foster-plants would be noticeable in the parasites later.

Mr. P. M. Lushington observes that "the disease seems very infectious as when once an area has been affected it rapidly spreads to the adjoining area and the actual area soon gets wiped out."

The reproduction of sandal, when once established in any particular locality, is prolific, and the area must eventually become over-stocked. Once this is so the appearance of "spike" is inevitable as the strength of the foster-plants is then insufficient to support the sandal, and a larger and larger area becomes affected as the sandal increases and spreads.

CONCLUSION.

From the above it will be noted that the recorded facts and observations in respect of "spike" do not contradict the theory advanced. They support it and in the majority of cases the support is strong. The same cannot be said in support of the theory that "spike" is a disease. In the event of the present theory being finally established the only remedy for "spike" would be to plant up the affected area with more foster-plants or to thin out the sandal. All affected trees would have to come out since they could never grow any bigger, and by taking them out the foster-plants would be given a chance to recover.

AN EXPERIMENTAL AREA OF *HOPEA PARVIFLORA*.

BY C. P. GARUDACHELLAM, FOREST RANGER, PUTHUR.

At the instance of the District Forest Officer, South Canara, (Mr. V. Ramen Menon) *Strobilanthes* was cut over an area of five acres covered with seedlings of 'Kiralbogi' (*Hopea parviflora*) in the Devachelia Reserved Forest during 1913-14.

I inspected the area after the heavy monsoon rains, I found that the seedlings of *Hopea parviflora* are growing well and the shoots from the cut *Strobilanthes* have preserved the moisture of the ground and the seedlings of *Hopea* are growing up with a straight and clean bole. The *Hopea* is the principal species in the Puthur Range of the South Canara district and the cutting of *Strobilanthes* promises to improve the forests considerably.

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NOTES ON FORESTRY IN THE U. S. A.

BY H. G. CHAMPION, I.F.S.

Having been granted leave by the Government of India to spend a year in the U. S. A. for special study before proceeding to take up his appointment in India, the writer of these notes sailed for New York on October 21st, 1914. The subject selected was Forest Entomology, additional facilities having been offered in this direction by a scholarship from the Carnegie fund administered through the Imperial Bureau of Entomology. On landing, he at once proceeded to Washington, D. C., where the head-quarters of the U. S. Bureau of Entomology, as well as those of the U. S. Forest Service are situated. The whole winter was spent there, largely taken up with becoming acquainted with the literature of Forest Entomology in the U. S., with the lines on which the work is run, as well as with the insects to be studied later in the field. Opportunities however arose and were seized, of seeing typical eastern hardwood and coniferous forests in the Alleghenies in the company of Mr. T. E. Snyder of the Bureau, to whom the writer is specially indebted in this connection: lumbering is going on all through the winter in spite of several feet of snow and very low temperatures.

Early in March a start was made on a tour of the western field stations of the Bureau of Entomology, beginning with Missoula, Montana, in the N. Rockies, which town is also the head-quarters of one district of the Forest Service (equivalent to a Circle in India). From this place, trips were made in various directions, the forests being chiefly of yellow pine (*Pinus ponderosa*) and douglas fir. On the Cœur d'Alene National Forest, Idaho, something of the Western White Pine (*P. monticola*), one of the most valuable timbers, was also seen, a sale area being visited in the company of the Supervisor.

Proceeding to Portland, lumbering operations in one of the famous douglas fir stands in Washington, close to the Columbia river, were made the object of a short trip, and one of the big mills in the city was visited: it is of course on the Columbia river that so much rafting is done, and where the large ocean-going rafts are made up for towing down the Pacific coast.

Turning southwards, six weeks were spent in and around Ashland, Oregon, where a special study of insect damage to the seeds of forest trees is being made: lumbering operations in yellow pine and sugar pine forests were visited, and further afield, near Crescent City, N. California, in the redwood forests and their marginal belt of sitka spruce: needless to say, the logging of the redwood is one of the most impressive sights of its kind to be seen anywhere.

The next field station is at Placerville, Cal., which is at the junction of the pine and fir forests with the foot hills and their characteristic chaparral or brush formations where the curious bluish leaved Digger Pine (*Pinus sabiniana*) with its giant cones is the only tree of any size. Flat-headed borers (*Buprestidæ*) were the object of special study here, apart from the general work on the bark-beetles.

After a short time in San Francisco, six weeks were spent in the Yosemite National Park on control work against bark-beetles attacking the pines there—chiefly jeffrey pine (*P. jeffreyi*), but the opportunity of seeing the Big tree, *Sequoia gigantea*, in its native condition at the well-known Mariposa Grove, was not allowed to slip: it was a matter of regret to the writer that he was unable to see this species being logged as it still is on the Kings River, although the stands do not equal those of the redwood.

Next a few days were spent in the Monterey Peninsula, where *Cupressus macrocarpa* may be seen at home, as well as other very local trees, and after a short stop in Los Angeles the journey was continued to Colorado Springs, Cal., at the foot of the Rockies on the eastern side. Here one gets yellow pine and douglas fir again, with Engleman and Blue Spruces (*Picea englemanni* and *P. parryana*), there is a small research station on the Pike National Forest near the town.

Returning to Wahsington, time was found before sailing for a visit to the Dismal Swamp in the northern part of the range of the Swamp or Bald Cypress, *Taxodium distichum*, though unfortunately one only sees here what the loggers have rejected or missed and it is now chiefly a hardwood forest. Eastern hardwoods were again seen in the neighbourhood of Boston.

As already mentioned, the whole tour was arranged for the purpose of studying methods of economic entomology and it was only incidentally that attention could be given to other matters of interest to the forester, but it has been thought it might be worth while to record a few of the notes and impressions collected. The writer had the pleasure of meeting many of the Forest Service Officers from the Forester, Prof. Graves, down to the Rangers and Forest Guards, some in the office and some in the field. Besides Washington, district head-quarters at Missoula, Portland and San Francisco were visited and valuable assistance freely given by the several District Foresters and their staffs, as well as much information about the National Forests under their charge, and adjoining privately-owned timber lands.

As in almost all respects the National Forest Service leads the way in matters of scientific forestry, it is primarily to the Service that the following notes apply :—

Of a total area of 3,700,000 square miles in the U. S. A., 860,000 square miles are under forest, and of this, 291,000 square miles are under national control. The Forest Service, formed in 1905, was too late to prevent by far the greater part of the first-class timber land falling into private hands (up to some 75 per cent. of the total stand), although some of the western forest lands include good, though usually at present rather inaccessible material. In the east, practically no virgin timber is in Government hands, but cut-over lands are being rapidly acquired.

The fact that the Service is credited on paper with an annual deficit of several million dollars does not represent the true state of affairs, for it ignores the functions other than revenue-producing assigned to the Service, especially the opening up of inaccessible territory, the improvement of transport and communication facilities, etc. Again 25 per cent. of all receipts from National Forests go to the counties in which they are situated, to be used for schools and roads. Further the cut-over lands in the east are acquired at the most expensive stage of their life as forests, and large grants of timber have been made free to other branches of the Government for the construction of railroads (*e.g.*, in Alaska), etc., apart from a free use exceeding one-third the amount sold.

The Service has been as a whole fortunate in its officers, despite previous lack of experience as to the most suitable methods of recruiting: this latter question still forms a matter of some difficulty at the present time.

Owing to the fact that private firms continually hold out offers of higher salary to experienced officials, such are occasionally lost to the Service, but the *esprit de corps* is high.

It should be mentioned that some of the individual States of the Union have in recent years acquired, and are still acquiring forest lands for public purposes, sometimes *qua* timber producing forest, sometimes for other reasons, such as the preservation of the Big tree, *Soquoia gigantea*, in California. The total timber thus involved is not inconsiderable, and if we include the miscellaneous forms of public ownership, it amounts to about one-seventh the volume standing on the National Forests.

ORGANISATION OF THE U. S. FOREST SERVICE.

The Forester and his staff are stationed at Washington: the country is divided up into seven districts, each under a District Forester, quartered with his staff at one of the largest and most accessible towns in his district. The administration of the 163 forests is under the charge of the supervisors, each with two or three assistants, and an office in a conveniently situated town; the executive rests largely with the Rangers living in Government provided houses out in the forest. A range has an average area of 300 square miles, and a forest 1,800 square miles.

The powers vested in each office are as usual in proportion to the responsibility of the office, so that, *e.g.*, a sale or grant for free use must be ratified by Ranger, Supervisor, District Forester, or Forester, according to its value.

It should be noted that the Government takes no part in the disposal of timber beyond seeing that the terms of the contract of sale are complied with, but these are becoming more and more precise—a fact which goes to put the Forest Service at a disadvantage in effecting their sales, as compared with private owners who make less stipulations

A few remarks follow dealing with some special points.

1. *Forest Engineering*—As already noted, this is all in the hands of the purchaser, except that he must abide by the terms of the contract. These commonly include provisions for—

(*a*) minimum diameter limit of 12"—16." Usually an exception is made of timber required for railroad-ties to be used on the spot;

(*b*) piling and burning of brush in a specified manner;

(*c*) handing over at the termination of the sale period of certain permanent improvements such as logging railroads.

The Government experts decide what engineering operations will be necessary for the extraction of a body of timber before the sale is completed: the stumpage-value is determined largely as a result of this, allowance being made for the necessary permanent improvements of the kind mentioned. It may be of interest to note that as an average conservative stumpage, value $1,50 per M. ft. B. M. is commonly quoted.

The *Logging Railroad* everywhere precedes all other methods of extraction over any but the shortest distances, even in very rough country; narrow gauge is exceptional. Many examples of this were seen where extensive bridge and viaduct building has been necessary.

Skidders are very widely used at the railheads. They have a radius of action of up to 3,000 feet and are especially useful in difficult terrain, both under eastern and western conditions, and for handling big logs. They may be of the simple hauling, or overhead-carrier types, the latter being usually adapted to work in both ways.

Both *Wet and Dry Slides* were seen up to three-quarters of a mile in length, but these do not seem to be very extensively used, especially where the timber is of any size.

Road building cannot be said to be much developed, perhaps on account of the high cost of labour, the non-permanent nature of forest operations, and the absence of a population which would use them after their primary function for timber extraction had

been fulfilled, nevertheless, the Forest Service constructed 350 miles of road in 1913.

2. *Working-plans.*—At the initiation of the Forest Service, a point to which much attention was paid, was the drawing up of working plans for publicly and privately-owned forests; these plans have, however, hardly ever been followed out So far regular working-plans have mostly been found impracticable. The Service is not cutting its total average possibility, and at present it concludes almost every reasonable sale it can. So long as this is the case, an equal annual return is impossible for the individual forest or even for a district.

Consequently the U. S. is not suited for the study of working-plans.

3. *Fire protection.*—This is the most highly developed side of modern forestry in the U. S. A. and reaches its maximum proficiency in California, District 5, where perhaps it is most called for.

A special feature is the "mobilisation scheme" whereby each officer from the District Forester downwards knows at once from a chart prominently posted in his office what aid in men, animals and tools are available for fire-fighting in any range, how this labour and equipment may be most quickly concentrated in that range, and how the supplies can be maintained in case of a lasting fire. This excellent organisation arose largely as a result of experiences of the very unsatisfactory nature of help called in on the spur of the moment (military troops, etc.).

The system of look-outs, patrols, and tool-caches, is also highly organised, whilst the maintenance of the telephones in good order is one of the chief cares of the rangers. In many cases, the ranchers and other settlers are allowed the use of these lines and thus given a direct interest in their maintenance. The Service has over 15,000 miles of telephone lines, and apart from their part in the fire-protection organisation their use in forest administration is considerable in that they do away with the necessity of written reports on minor matters, allow daily reports on important affairs and so on. Great care is taken that the trails by which a possible fire may be reached are open before the fire

season begins. All fires are reported to the district office, and marked in on the map in the District Forester's office with pins variously coloured to represent the area burnt over: *inter alia*, this facilitates the recognition of the origins of the fires, such as incendiarism. The cause of the fires is always recorded where possible, and embodied in the annual report.

There is effective co-operation for fire protection between private owners, and between them and the Federal and State authorities. Nearly half a million square miles of forest are thus protected rather over half by the Federal Government.

The question of liability for causing a forest fire had several times come before the U. S. courts, and although no definite recognition of the principle of expectation values has been given, damages between these and realisation values have been recently awarded. The effect of this has been very salutary on the railroads, etc., which in many cases have organised their own fire-patrols which follow every train along the tracks after an interval of about half an hour, Gasoline 'Speeders' trolleys being commonly used for this purpose. The danger in the west comes primarily from the small lines on which alone wood fuel is now used, so completely has oil replaced other combustibles. In some regions the fires are mostly set by lightning.

Rules and advice concerning the building of camp fires, etc., are freely advertised both in the forest and out, but more weight is given to educating the public to a realisation of the value of forests to the community than to a rigid enforcement of these rules.

On the 163 National Forests, 6,112 fires were reported and extinguished in 1914, and the loss caused by them estimated at $400,000, and this was considered a very bad fire year. The average annual loss from fire in the whole country is estimated at $25,000,000 for timber alone, three fires in 1910 swept over 2,300,000 acres in Idaho, Montana and Minnesota and burnt 127 persons to death. One portion of the Idaho area was traversed by the writer and it is a most impressive sight.

4. *Milling.*—The mills are all in the hands of the big timber companies, and for the most part are exceedingly efficient. One

mill at Portland, Ore., visited, sawing chiefly douglas fir, has a daily output of 200,000 ft. B. M., and some mills handlings swamp-cypress in the east have a similar amount, using two double-cut hand-saws and resaws. These figures are by no means unusually high. The labour employed is highly skilled and commands high wages, but the lumber industry is at present suffering under a general depression. Many mills in the east are having to close down with the exhaustion of all the available timber, but the southern pine (*P. echinata*, *P. palustris* and *P. taeda*) region still furnishes over 40 per cent. of the total annual production.

Pulping.—Several pulp factories were visited, all of them in the east, and using primarily red spruce and hemlock. Both sulphate and soda processes are in common use, and more attention is being given to the utilisation of waste products, such as resin.

5. *Research Work.*—It is admitted that research work along sylvicultural lines has hitherto been altogether too diffuse, and has consequently not produced such results as could have been wished. Recently the whole has been reorganised and officers detailed for the work: all proposed lines of research are now submitted to the head office in Washington before being started upon, and the general programme is also drawn up by that office.

The laboratory for research work on forest products at Madison, Wisc., which gives employment to some 50 men, has done much good work.

6. *Nurseries and Reafforestation.*—In recent years there has been a marked tendency to cut down the number of forest nurseries to a minimum of one in each district, large enough to supply the needs of the whole district, except where special local conditions call for a small nursery in the immediate neighbourhood. Many of the State Forest Services maintain their own nurseries, but much stock is still imported from Europe. It is a common custom to distribute a large portion of nursery stock to private owners at cost price.

Planting up of denuded or fire-swept areas has been extensively carried on in some localities, but with very unequal success.

30,000 acres were thus treated in 1913. Some lack of method was observed and the writer expects to see marked development in this direction now that fire-protection is so well organised as to give more time for the consideration of this problem, second only to it in importance, and like it, a matter of considerable expense.

NOTE ON THE DIFFERENTIATION OF "IN" AND "KANYIN" SPECIES OF *DIPTEROCARPUS* TIMBER OF BURMA.

BY PURAN SINGH, F.C.S., CHEMICAL ADVISER TO FOREST RESEARCH INSTITUTE, DEHRA DUN

Introductory.

In 1913, samples labelled (1) "In," (2) "Kanyin ywet-gyi" and (3) "Kanyin-ywet-the" were received from the Divisional Forest Officer, Toungoo, Burma, through the Forest Economist with a view to finding some ready field test for distinguishing them from one another and it was suggested that a reagent producing different stains would answer the purpose. The preliminary examination showed that "In" contained 3·55 per cent. of oleo-resin and 0·3 per cent. of ash, while "Kanyin-ywet-gyi" and "Kanyin-ywet-the" contained 3·53 per cent. and 1·42 per cent. of oleo-resin and 0·4 per cent. and 1·2 per cent. of ash respectively. The insoluble ash gave reactions for iron which was found to occur in the ferrous condition in the wood on examining its aqueous extract. It was seen that 10 per cent. of potassium ferricyanide solution gave a green stain on all the three timbers. All the three woods being of similar nature, it was rather difficult to distinguish one from the other merely by staining them. Instead of trying the surface staining, five grams of the shavings of each were placed in three separate beakers to which 10 cc. of 10 per cent. solution of potassium ferricyanide and 50 cc. of water was added. All the three beakers were kept at the boiling point for five minutes with the result that each of them developed coloration and they were capable of differentiation by this method.

Another method that was tried in the preliminary work on the subject depended on the relative rate of the exudation of the

oleo-resin from equal pieces of "In" and "Kanyin" timbers exposed to an atmosphere of hot air at 130—150°C.

A preliminary note was sent to the Divisional Forest Officer, South Toungoo Division, to try these two methods in the field. He reported that Mr. R. Unwin, B.Sc., Assistant Conservator of Forests, tried the methods suggested with results similar to those obtained at Dehra Dun and that the original object of the enquiry being to discover some means of separating the timber of "In" from that of "Kanyin" (the separation of the two species of the latter timber being immaterial), the resin test alone could provide a simple and sufficient means of attaining this object. This correspondence, however, revealed that there was some mistake in labelling the samples examined at Dehra Dun, because the Chemical Adviser had reported just the opposite of what Mr. Unwin had found, *viz.*, that the exudation of resin from "In" is less than from "Kanyin," while Mr. Unwin found that it is more in "In" than in "Kanyin." The question was again referred to the Chief Conservator of Forests, Burma, for definite settlement. Mr. A. Rodger, the Research Officer, Burma, has recently tried the method on "In" and "Kanyin" timbers, collected by himself with the same results as obtained by Mr. Unwin and reports that "In" exudes more resin than "Kanyin." Mr. Rodger has kindly sent again six more specimens of "In" and "Kanyin" carefully labelled by himself for a fresh trial at Dehra Dun with a view to verifying the results obtained by him in the field.

This note embodies the results of the trials made with the specimens sent by Mr. Rodger to whom the writer's best thanks are due for finally clearing up the matter. The specimens had the following marks :—

0 ...	...	In-Dipterocarpus.	
1 ...	...	Kanyin byu	Kanyin.
2 ...	.	In-Kanyin	Kanyin.
3 ...	...	Kanyinni	Kanyin.
4 ...	...	Kanyin-mwezok	Kanyin.
5 ...	...	Kanyin gyi	Kanyin.

Analysis of the samples.

The following is the preliminary examination of the specimens given above :—

Mark of the sample.	Name.	Moisture %	Ash %	Oleo-resin %	Colour of the timber.
0	In Dipterocarpus ...	11·80	1·00	4·64	Red brown.
1	Kanyin byu ...	29·61	0·71	1·10	Light red brown.
2	In-Kanyin ..	11·72	0·85	0·75	Light grey brown.
3	Kanyinni ...	15·03	0·16	0·94	Dull red brown.
4	Kanyin-mwezok ..	13·86	0·74	0·62	Ash grey.
5	Kanyin gyi ...	13·22	0·22	2·18	Red brown.

The Stain Test.

The stain test was tried as described above with the following results :—

Mark.	Deposited precipitate at the bottom.	Colour of the supernatant liquid.
0	Blue	Dirty faint yellow.
1	Do.	Green.
2	Do.	Do.
3	Do	Do.
4	Do.	Do.
5	Do.	Do.

Though all *Dipterocarpus* species give a blue precipitate on this treatment, yet the colour of the supernatant liquors at once distinguishes "In" from "Kanyin." It is not of course possible to distinguish "Kanyin" varieties from each other.

The application of this test however in the field is somewhat difficult. It requires that similar quantities of material be taken and boiled for the same time, and that the observation of the difference in the depths of the colour be made after cooling each extract for the same length of time.

The resin-exudation test.

This test can be easily carried out in the field as follows :—

Take an ordinary galvanised box about $1' \times 6'' \times 6''$ with well-fitted cover carrying a thermometer reading up to 300°C. and four hanging wire-supports to take two pieces of wood $4'' \times 2'' \times 2''$ on each side. Heat the box on a "Primus" stove till the temperature rises to 120°C. Take off the lid and suspend pieces of the same size of "In" and "Kanyin" inside by placing them on the hanging wire-supports. The cover is then replaced. The heating is continued for another 15 minutes, the temperature rising to about 150°C. and it may be allowed to go as high as 170°C. The pieces are taken out and the exudation observed. It was tried on the six specimens by taking pieces of $3\frac{1}{2}'' \times 1\frac{1}{2}'' \times 1''$ and exposing them to a temperature of 140°C. for 15 minutes. It was found that "In" exuded most resin, and all the "Kanyins" showed but nominal exudation of resin. Thus it was at once easy to distinguish "In" from the "Kanyins. Of the "Kanyins," No. 5, *i.e.*, "Kanyin gyi" showed the most resin, the next was No. 4, *i.e.*, "Kanyin-mwczok," less than No. 4 were Nos. 1 "Kanyin byu" and 3 "Kanyinni," No. 2 showing no exudation.

Mr. Rodger's experiments.

These results agree with the results obtained by Mr. Rodger in the field. The following is an extract from a letter addressed by him to the Forest Economist :—

"*1st Experiment.*—Small blocks of 'Kanyin' and 'In,' 15 minutes at a temperature of 130°—150°.

A. 'Kanyin-in' wood from just inside the sapwood—no exudation.

B. 'Kanyin-in' wood from the centre of the log—no exudation.

C. 'In' wood from just inside the sapwood—slight exudation.

D. 'In' wood from the centre—no exudation.

2nd Experiment.—Same blocks treated again, this time for 30 minutes at a temperature of 138°—180°.

A. no exudation.

B. very slight exudation.

C. *marked exudation.*

D. very slight exudation.

3rd Experiment.—From a cross section of an 'In' log, $8\frac{1}{2}''$ in diameter, and $3''$ thick, a piece was split out across the centre.

The width of the piece was $\frac{1}{2}''$—$\frac{3}{4}''$. One edge was chiselled off clean so as to leave all the vessels open. A piece of 'Kanyin byu' almost of the same size was treated in exactly the same way, and the two pieces were put side by side in the stove for ten minutes at a temperature of 120°—160°. Great exudation occurred from the 'In' and practically none from the 'Kanyin byu.' There was no exudation from the sapwood in either case. The exudation from the 'In' was almost uniform all across the heartwood. These experiments seem to prove that it is 'In' and not 'Kanyin' that exudes resin in quantity when heated.

2. I notice that 'In' when heated produces a strong characteristic resinous smell, and that the two kinds of 'Kanyin' have only a faint smell, not nearly so distinct and characteristic as 'In.' By heating a piece of 'In' with a piece of wood which it was desired to name, I am sure that the smell would be a good guide as to whether the unknown piece was 'In' or not."

Mr. Rodger's third experiment conclusively proves that it is "In" and not "Kanyin" that exudes resin in quantity when heated. He has made a useful additional observation that the specimens to be tested must be drawn not from the sapwood but from the heartwood. As regards Mr. Rodger's observation that "In" gives a strong characteristic resinous smell as compared with the faint smell of the "Kanyins," this is borne out by the fact that "In" contains more oleo-resin than the "Kanyins." The nature of *Dipterocarpus* oleo-resins in all its species is however similar.

Conclusions.

It has been definitely established that it is possible to separate "In" from "Kanyins" by both the colour test, though this would not usually be feasible in the field and by the resin-exudation test. The only precaution necessary is that pieces of exactly the same dimensions and drawn from the heartwood should be taken for these comparative tests.

ARBORICULTURE.

THE MOUND AND PIT METHOD OF PLANTING.

BY F. TRAFFORD, I.F.S.

The usual way in which an avenue of trees is created is to place a seedling in a pit, carefully make a basin for its reception and water it steadily every hot season for some years until it grows large enough to fend for itself. The drawback to this method, and it is one which puts it out of the pale of practical forestry, is the expense of constant watering and the risk of the young plant being killed if this watering is in any way neglected. The young tree having an abundant supply of water on the surface develops a large superficial root-system and does not exert itself to force its roots into a substratum of soil which by constant watering has got consolidated and in the rainy season is in a more or less water-logged condition.

The method about to be described has been found to be effective in raising the maximum of plants with the minimum of water and has been gradually evolved during the afforestment of a bare and more or less rocky ridge in the arid climate of the Central Provinces. It consists of a pit about two feet deep filled in with a loose mixture of earth. The addition of a small bundle or two of stems or twigs to keep it well aerated would probably be sound. On this a mound a foot or so high is constructed and a handful seedlings two or three months old are placed on each mound so that the roots of the inner ones are not exposed to the air in transit.

The pit and mound are made as soon as possible after the rainy season so that the soil in the pit does not become consolidated before the seedling has time to throw its roots well down. A little late rain will do good. The soil on the mound must be kept broken up and powdery, the surface being raked up after every shower which may occur early in the cold weather so as to prevent the elimination of moisture by capillary attraction. If it is found absolutely necessary to administer water it should be done in small doses and preferably through a hollow bamboo or bundle of twigs buried in the mound, the idea being to induce the roots to grow down as rapidly as possible into the pit.

The addition of the mound serves two purposes. It keeps the soil in the pit cool and moist in the hot weather and by throwing off the rain prevents the soil in the pit becoming first water-logged and then consolidated in the rainy season. It enables the young tree to obtain an abundant supply of air for its roots in wet weather while the pit supplies the necessary moisture in the hot season. In this way the young plant is enabled to cope with those rapid alternations of dry and wet weather so common in most parts of India.

The gravelly nature of the soil where this work was carried on necessitated the digging of deep pits. In better soil a pit a foot deep or even less would probably be sufficient to give the plant a good start in life, a good mound however is essential in any case.

Should any of your readers be required to carry out planting under unfavourable circumstances the above method, if not already adopted, is confidently recommended and may be given a trial.

NOTES ON THE FOREST ADMINISTRATION IN OUDH, FORTY YEARS AGO.

The forests of Oudh some 40 years ago were entirely separate from those of the North-Western Provinces—Oudh being then a separate province under its own Chief Commissioner. The earliest report that we have at our disposal is that for the year 1871-1872.

The receipts of this year were Rs. 1,38,000 and the expenditure Rs. 1,26,000, showing a surplus of Rs. 11,000.

The chief heads under which the revenue was collected were timber sold from depôts some Rs. 49,000, timber sold in the forest some Rs. 41,000 and grazing dues Rs. 36,000.

The object aimed at at that time was to remove all timber departmentally. The chief timber sold was Sal, Sissoo, Khair, Dhaura or Bakli (*Anogeissus latifolia*) for cart-axles and Kusum (*Schleichera trijuga*) for oil-crushers.

Great complaint is made in connection with the unlimited grazing that went on, which destroyed or prevented any regeneration. The Conservator remarks that in sample areas where he excluded grazing the reproduction was excellent. As at present, the two best timber divisions were Kheri and Bahraich.

The total area of the Government forests in this Circle was something over 800 square miles, and this area was gradually increasing owing to the resumption of old grants. Settlement there was none, while survey and demarcation were very rough. An endeavour was made to form a thorn hedge of Khair around a portion of the more valuable Bahraich forests; this does not seem to have been very successful. We have also seen old cactus hedges round portions of forests in Oudh—at times these were fairly successful but appear to have been considerably damaged by porcupines.

Various small plantations were tried and it is noted that "short pieces of small roots of Sissoo were planted horizontally and sent up vigorous shoots." This method, which we have not previously seen adopted, commended itself to the Conservator. As it does not appear to have been persevered with it probably was found not to answer on further experience.

In the Kheri Division the working plan of those days prescribed a felling of 3,213 selected trees—nearly 500 short of this number were actually felled, "the cause of the incomplete felling was the extreme care and long time taken in selecting the trees." This excuse appears to have been rather a shallow one but it seems to have been accepted.

The report of the year is a meagre one covering less than ten pages, but the Chief Commissioner appeared to be satisfied with the progress made. Forests were not considered as important then as they are now.

The report of the following year deplores the fires that swept through the forests, though it is stated that the Sal forests are improving every year.

It is stated that the Kheri Division contains the only Sal timber forest capable of being profitably worked departmentally. This is not very clear as some 2,500 green *Sal* trees were sold to purchasers in Bahraich and they do not appear to have been losers by the transaction, why then could they not have been removed departmentally? The purchasers apparently selected their trees and this is admitted to have been a mistaken policy.

Steam sawing machinery was indented for and received from England and located at Bahramghat, this was maintained till about 1895 when it was sold off.

The surplus of the year was about Rs. 86,000 which was considered satisfactory.

The Conservator is taken to task by the Chief Commissioner for merely quoting the opinions of his assistant in his report, whose "suggestions and observations, although no doubt valuable in themselves, would have been of greater weight had they been endorsed with some expression of opinion by Conservator."

The review states that the frequency of fires might have been reduced by a little extra supervision. This reads well but ignores the fact that any increase of establishment had been refused and little money was made available for fire-conservancy or anything else.

We pass next to the following year 1873-1874. During this year the permanent Conservator returns from leave and criticises what has been going on in his absence. "I recommended a new system of timber operations, but in my absence no notice was taken of the latter." "The selling of green Sal trees standing referred to by the officiating Conservator in last year's report was quite exceptional and he saw too late the mistake he had made."

"The officiating Conservator did not comprehend the difficulty of collecting......................................" Evidently the permanent Conservator held the opinion that he was the only man capable of administering the Oudh forests successfully. Service in his Circle could not have been very attractive.

The average growth of Sal from experiments made is stated to be ·2″ of radius annually so that a tree of 4′ 6′ girth takes 14 years to pass into the 6′ girth class. This seems rapid and has not been generally borne out as far as our experience goes. Based on these data the Conservator now proposes a 20 years' rotation in place of 40 years. The Chief Commissioner frankly acknowledges that he has not the requisite knowledge of arboriculture to judge of the propriety of the Conservator's proposal and will not adopt it until he has the professional opinion of the Inspector-General. The Conservator's sylvicultural knowledge was evidently not much trusted in those days. The Conservator considers that few of the standing Sal trees "have come from seedlings proper direct, but have been kept down by fires and other causes and when their roots have been firmly established they have shot ahead."

He further adds that when there is a good stock of seedlings everything should be cut over flush with the ground and allowed to start afresh, cattle and fires being kept out at almost any cost. This is all very well but the Conservator does not state how he proposes to keep out fires and cattle, a matter of great importance. Looking to the Chief Commissioner's remarks "This section of the report is a melancholy record of the continued failure of the department to preserve the forests from the ravages of fire" while

the Government of India resolution notes that "the Conservator reports that the forests have been burnt much as usual in spite of the indefatigable efforts of his assistants."

"The yield in the year has been very good: as a rule we cut one tree out of three first class trees per acre (on an average two-thirds of the trees are not suited for timber)........................." This savours much of revenue hunting and is a fair sample of how the forests were worked in the early days of the department.

The surplus of the year improved to some Rs. 1,04,000 and the average surplus of the 12 years of working, that is we suppose since the forests came under professional(?) management, is shown to have come to about Rs. 58,000.

The following remark of the Chief Commissioner reads to us curiously: "The selling of standing Sal trees is an experiment not likely to be repeated.........................the expressed desire of the Government of India for its gradual abandonment should be borne in mind." How the department proposed to work the forests departmentally with the very small staff at its disposal is not clear.

The Chief Commissioner is at a loss to understand the record of forest offences. "It is not understood why Oorce, ahir, was proceded against for 'sitting under a tekoee tree.' His fate is uncertain, for whereas in Appendix II he is said to have been released, it would seem that in all cases not pending convictions were obtained."

The Government of India resolution on the report of the year 1873-74 is the first one that we have been able to lay our hands upon. It is not very complimentary. "The report contains no evidence of material improvement in the condition of these Government Estates," and asks that the exclusion of cattle from a portion of the forests at least be seriously considered, further suggesting the closure against all cattle of forest which has been fired, "and such a measure would only be admissible in forest tracts where no rights or privileges exist." This latter clause seems too sweeping—it is surely open to the Local Government to revoke at any rate privileges. Clearing the forest of rights and

privileges is advocated even if considerable areas have to be given up. "An essential condition is that the blocks remaining at the disposal of the Government should be of as large extent and compact shape as possible." If this had been borne in mind in other Circles that we could name outside Northern India much of the friction that has been prevalent in them would have been avoided.

Again "........... measures advocated by the Government of India ever since 1868 that a diminished area of forest land if under complete control may produce a larger yield of material and revenue than the present area under existing conditions." We agree entirely.

Exception is taken to the want of care shown in preparing the statements to the report and looking through them they are not very intelligible.

Taken altogether the reports of these three years do not show the administration of the Oudh forests in a very favourable light judged by the standard of recent years; at the same time every allowance must be made for an untrained and very small staff and the backward condition of the people surrounding the forests, the competition of Nepal and *zamindari* forests of which there were large tracts and the limited measure of support accorded to the department by the Government of those days.

AN ENCOUNTER BETWEEN A WILD CAT AND A PEACOCK.

Being attracted by an unusually loud calling of peacock, my brother and I went up to investigate. We flushed a number of peafowl and a pig and discovered a wild cat (*Felis chaus*) dead but still limp and a peacock alive squatting on the ground unable to move and gasping with his beak open. The whole place was littered with peacock feathers and it was evident that a fierce struggle had taken place out of which the peacock had emerged

the victor though whether he would have lived much longer was doubtful, as I naturally put it out of its pain. From the wounds on the two animals it would appear that the cat had seized the peacock by the fleshy part of the body above the tail first on one side and then the other. The peacock had retaliated by vigorous pecks directed at the side of the cat's neck and had dug a hole and eventually probably severed a large vein or artery which put an end to the last of the cat's lives.

The circumstance must be very unusual. The cat was quite full-grown and must have been extraordinarily fierce to have held on as she did till she was killed. Whether any of the other peacocks helped I can't say, but think it extremely doubtful. They and the pig were probably spectators of this jungle tragedy.

R. THOMPSON.

I can vouch for the above story as I saw both animals shortly after the tussle. I wonder whether any of your readers have come across a similar case. I imagine that in most cases the wild cat gets the best of the encounter and a meal into the bargain.

F. TRAFFORD.

AN ELEPHANT'S PUNISHMENT.

BY G. N. SIMEON, I.F.S.

The accompanying four photographs (Plates 19 and 20, Figs. 1 to 4) showing the punishment meted out to a bad-tempered elephant may be of interest to readers of the *Indian Forester*.

The delinquent is Buxa Bahadur, a large "mukna" elephant belonging to the Forest Department in the Goalpara Division in Assam, and he has long been notorious and is carefully avoided on account of his homicidal tendencies.

I wanted to get a photograph of him one day and had gone up fairly close (he was hobbled and chained to a tree at the time). He happened to be facing me, and I moved round to one side to get a better view of him. As I did so he made a dash forward at

me as far as his chain would allow and hurled a large stalk of fodder which he had in his trunk and which shot past me like an arrow. His Mahout then came up and tried to go up to him but was ignominiously routed. Fig. 1 (Plate 19) shows Buxa in an aggressive attitude, the Mahout being off the picture on the left as hard as he could go.

As Buxa then proved obdurate to the blandishments of a 7-foot barbed spear kept for these occasions I sent for the "tusker" Utam Prasad, an elephant about the same size as Buxa but of whose tusks Buxa is in mortal terror. As soon as Utam Prasad arrived on the scene Buxa caved in at once and cringed for all the world like a whipped puppy. He allowed himself to be hobbled with extra ropes, and his Mahout was able to get up on to him. Fig. 2 (Plate 19).

When he was securely tied fore and aft, his Mahout got down and Utam Prasad was told to give him a hammering. Figs. 3 and 4 (Plate 20) show various stages of this. In Fig. 3 they are engaged in a pushing match where Buxa being hobbled was nearly knocked over, and in Fig. 4 Utam Prasad has just caught him a good bang in the ribs.

After about ten minutes of this rough handling Buxa was left sorry for himself and rather cowed to meditate upon his sins. It is very fortunate that we have an elephant of whom Buxa is so afraid, for otherwise he would be unmanageable at times. Unfortunately the "tusker" himself is bad-tempered and untrustworthy and if they both happen to go "masth" together the only thing to do is to tie them both securely and wait till they get all right again.

The redeeming feature of both elephants is that they are very powerful and excellent baggage animals in their saner moments.

Fig. 1.

Fig. 2.

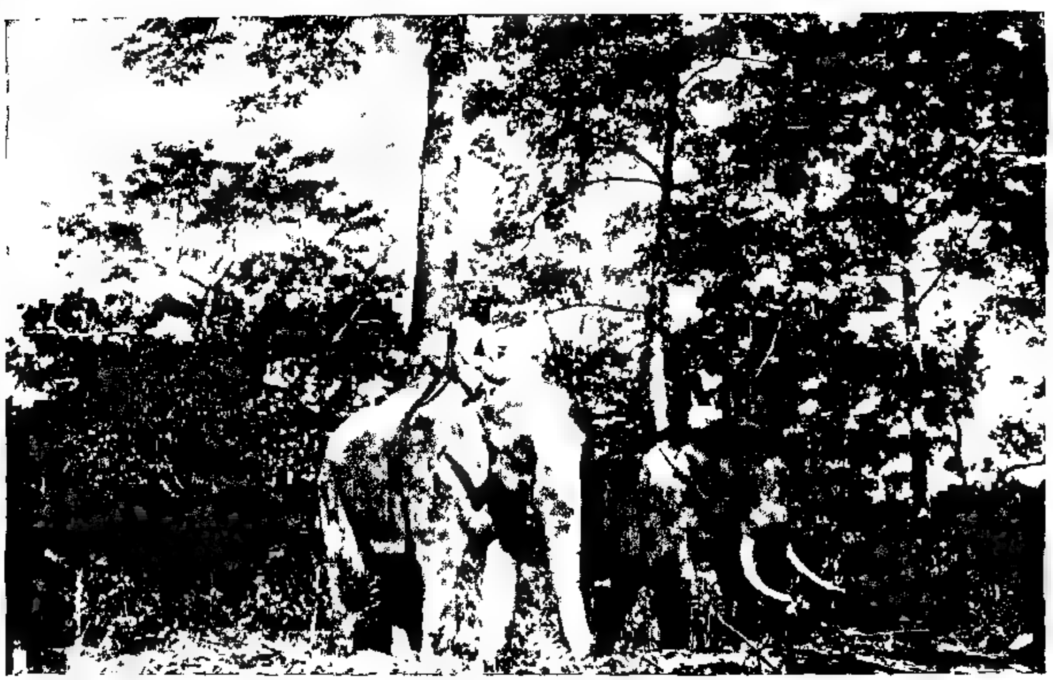


Photo-engraved & printed at the Photo.-Mech., & Litho. Dept., Thomason College, Roorkee.

AN ELEPHANT'S PUNISHMENT.

Fig. 3.

Fig. 4.

Photo-engraved & printed at the Offices of the Survey of India, Calcutta.

AN ELEPHANT'S PUNISHMENT.

TURPENTINE OIL AND ROSIN FROM *BOSWELLIA SERRATA*.

In their useful investigations of the products of the Empire the Imperial Institute authorities, in their *Bulletin* of July-September, consider the possibility of utilising the oleo-resin of *Boswellia serrata* for the production of these useful commodities. The oleo-resin of this tree, which is fairly plentiful in India, is sometimes known as Indian frankincense, and it finds a limited use locally as an incense in the temples, also as a remedy in rheumatism and debility. The export of this oleo-resin is at present small, amounting in 1913-14 to 778 cwt., to the value of £1,339, most of which went to Germany and Austria, where they no doubt needed it. Now the question is, how to utilise this oleo-resin ourselves in some more useful manner, and with this end in view the authorities at the Forest Research Institute at Dehra Dun distilled a portion of it in a copper still with open steam and obtained from it both

turpentine and rosin, samples of which were forwarded to the Imperial Institute for further examination. The turpentine oil had a slight greenish hue and a sweet agreeable odour. It had a specific gravity at 15° C. of 0·8446 and a specific rotation of $[a]_D$ $+31°24'$. On fractional distillation 89 per cent. passed over between 155° and 160° C., and 11 per cent. between 160° and 180° C., so that it differs very little in this respect from American or French turpentine. It behaved very similarly towards resins as ordinary turpentine, but dried off a little more quickly, which may be remedied, if necessary, by including some of the higher boiling point fraction.

The resin left after distillation was dark coloured, and differed from ordinary rosin in its composition and properties ; for instance, it had an acid number of about 50 and a saponification number of 92, and, therefore, it could not replace the last-named in most of its uses, such as, for instance, paper sizes, soap making, etc. It also gave a brittle coat, therefore it would be of no use in varnish manufacture. No doubt it could be employed in the preparation of common sealing-wax and cements ; other uses may also be found, just as there has for the rubber resins, which fetch almost as high a price as common rosin. Some experiments were tried on the dry distillation of this resin for the manufacture of rosin oils, but the products obtained were quite different from those obtained from ordinary rosin, so that this did not promise to open out a use for the material.—[*Oil and Colour Trades Journal.*]

OUR FOREST DEPARTMENT.

We are glad to find that an officer, writing in the *Indian Forester* of January 1916, refers to the probable great expansion in the teak timber trade for ship-building purposes after peace has been restored. The loss in ships has now totalled to a very large figure and so far from diminishing from week to week is actually on the increase. From being confined at first to vessels of small tonnage, or trawlers, it has extended to liners and the scene of destruction has also spread considerably. Trade everywhere is suffering from a deficiency in tonnage, stocks are being accumulated

and an outlet must be found for such stocks as quickly as possible as soon as normal times will have returned. Nor is there the smallest doubt that once the Panama Canal has been set on a permanent working basis there will be a material expansion of sea traffic, and lastly, if the purpose of the war be attained, *viz.*, that a lasting era of peace and prosperity is secured for all nations of the earth, a great fillip will be given to commerce, affecting practically every country of the world. The nations will therefore shortly be crying out for many more ships than they have ever had and will have not only to restore those that have been sunk but to add largely to their fleets. Now, the favourite timber for ship-building all over Europe is teak, and the teak that is used comes practically wholly from Burma and Siam; that is, it is our Indian Forest Department that controls most of the supply. The supply before the war scarcely met the demand and consequently the price of teak has more than doubled in the last 30 years. It is now up to the Forest Department to gird itself to increase the production, and we find an officer in the service showing in the *Indian Forester* how it might be done. By the exercise of some pressure and energy the new Lieutenant-Governor of Burma has in a brief period put the tungsten ore industry of the Province on a footing that will ensure an outturn of many times what it was six months ago. He may perhaps be able to turn his energies next on the expansion of the teak industry; but it needs to be done at once if the Province is to reap results during the period when demand threatens to be greatest. Those interested specially in the subject should read Mr. Hopwood's Paper and the two preceding it. Here we can refer briefly only to the remedies he suggests. It is necessary to girdle teak trees three years before they are felled, so if three years hence it is desired to materially augment the supply additional girdling must be undertaken at once. Mr. Hopwood thinks the forests will stand doubling or trebling of the girdling programme during the next five years, and also thinks there is a large number of trees in the forests that are already over-mature and must perish if not removed. The additional girdling can no doubt be effected by the department with more staff and energetic supervision, but pressure

must be brought to bear on the lessees to remove without delay all girdled trees. There is a tendency for them to remove only the most valuable trees, neglecting others that the department has girdled, since the royalty they pay is only on such timber as has been removed to an appointed measuring station. Obviously lessees must be deprived of this liberty and must accept as marketable all trees that the Forest Department select for girdling, the department on its side guaranteeing that girdling is effected only by reliable and responsible officers.

Another long view for the department to take is that, besides being first favourite for ship-building, teak is also used largely for railway carriages in India. The stringency of money has caused railway grants to be much reduced in the last two years and hence building programmes have had to be cut short. But as the traffic on Indian railways instead of being curtailed has been carried on under greater pressure than ever, this only means that expenditure on stock-building is being deferred, that what is not being spent during the war must be spent after it, and in addition to expenditure then current. The demand for teak for carriage-building may therefore, before we expect it, go up with a bound to twice what it has ever been. And the same may be said of other timbers required for sleepers. It is practically certain that railways are experiencing some anxiety in maintaining their lines to the standard they desire, and that any saving on the item of sleepers must be countered by very large expenditure a little later. If our Indian forests are then unable to meet the demand foreign sleepers will be brought in to flood the country and the profit to the Indian Forest Department be thus lost. The present then is the time to strengthen the commercial side of the service, since a boom must shortly come, and any business lost then may be lost for ever.—[*Indian Engineering.*]

HOW TO MEET THE DEMAND FOR BRITISH TIMBER.

It is most unfortunate that the tendency of the war has been to seriously check planting operations, and at the same time to greatly increase the felling of all kinds of timber. The war has certainly brought home to us in a clear and unmistakable manner the danger of relying too much on foreign supplies of timber, and it is to be hoped that after peace we will settle ourselves down to make amends, not only for past neglect in that way, but in order to make up for lost ground by replanting some, at least, of the land from which timber has been felled. But unless the Government takes steps to stop the present tendency to check planting and hasten felling, another year of war will most certainly find this country seriously denuded of its best timber.

We are no pessimists, but unless something is done, such as by Act of Parliament, to either induce replanting or stay the axe of the woodman, the woodlands of our country will be sadly depleted in another year or two. Heretofore, the State has done extremely little, either in extending the area of our woodlands and plantations or in inducing owners of suitable land to do so themselves.

The war is making unusually large demands on timber all over the Continent, as well as at home, and it is quite possible that, when foreign supplies are greatly diminished, we will be compelled to make severe inroads on our own resources. To those who rightly regard our forests as a national asset it is quite plain that, in order to keep up supplies for the future, replanting of ground from which a timber crop has been cut is the only feasible way of facing the difficulty.

When we consider that the total area of woodlands in this country is only a little over 3,000,000 acres, that fully 15,000,000 acres of waste lands exist, and that we annually import over 10,000,000 tons of timber at a cost of nearly £30,000,000, the necessity for an increased area of woodlands will be apparent to all, and the more so as a dearth of timber is imminent and outside supplies are being rigidly conserved, while our home demands are ever on the increase.

Taken as a whole, Europe has not enough timber to meet her demands, about 4,000,000 tons in excess of what she produces being annually required, and stringent laws have been passed regulating the output. This is the case with Norway, Sweden, Finland and Russia. The Canadian forests and those of the United States are both nearly exhausted, and by a competent judge it has been said that in fifteen years little or no timber will be left if depletion goes on in those countries as at present. But the worst is that there are no forests to fall back upon, for the timber of those of Africa and India and South America is unsuited generally to our wants. Australia, China and Japan require at present more timber than they produce.

For the past five and twenty years I have not failed to urge on private owners of woodlands pressing necessity of planting up some at least of the waste and unprofitable lands of our country in order to provide timber for the future, and leave us less dependent on the gradually dwindling supplies that are annually sent us from abroad.

England being, so to speak, a residential country, the retention of a certain amount of heath, mountain and commons land for the purpose of deer forests, grouse moors, game coverts and golf links is imperative, and will considerably pose. But I think that I am well within bounds in allotting out of the 15,000,000 acres of waste lands 1,000,000 acres to afforesting and 14,000,000 acres to game preserves and recreation

Having personally explored much of the mountain and heath lands in England and Scotland and some of the vast tracts of bog land in Ireland (which alone extend to fully 1,125,000 acres), I have carefully computed that of the land up to 1,200 feet. Where timber would grow perfectly well, about 9,000,000 acres are available for afforesting purposes. As far as I have been able to find out, the average rental of such ground would be considerably under 3s. per acre, while, on the other hand, I am quite convinced that any land which does not bring in at least three times that amount for grazing or agricultural purposes would be more profitably employed in carrying a crop of timber. It is, perhaps, unfortunate

that much of these waste lands is private property, the owners of which, even could they afford it, have little inclination to sink, for a period of, say, twenty-five years, the necessary capital required to be expended on the formation of woods and plantations.

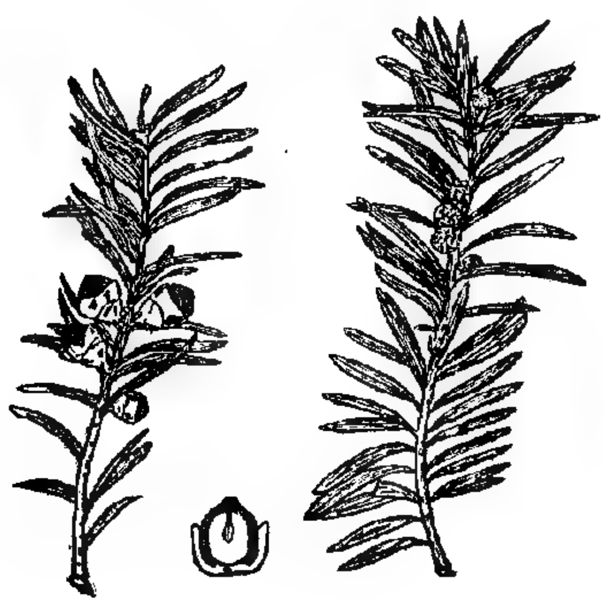
Under such conditions the question naturally arises, What is the most feasible way to overcome the difficulty? In answer, and without the slightest hesitation, I would say that suitable waste lands at the rate of 40,000 acres should be planted annually, for a period of, say, twenty-five years. Such lands could, in England, Scotland, Wales and Ireland, be gradually and cheaply acquired where the owner himself was unwilling to plant, and in Ireland vast tracts of bog land would be willingly handed over at the present moment at a small sum per acre. Quite recently, in Wales, 7,412 acres of upland described as "rough grazing and sheep walk" was sold by public auction for £15,670, or at the low rate of £2 2*s*. 3*d*. per acre. The land was particularly suitable for the growth of larch, as the highly remunerative plantations adjoining clearly pointed out. But numerous similar cases could be given, so that the excuse of no available land is not tenable. They could be dealt with by a waste land reclamation society.

After careful computation, I have no hesitation in saying that the area of plantations in the United Kingdom could at once be doubled by the planting of waste lands which at present do not bring in over 2*s*. per acre of rent annually, with infinite benefit to the country generally and a vast increase in the value of land both to the owner and farmer who cultivates it. I have already suggested that altogether 1,000,000 acres should be planted over a period of twenty-five years at the rate of 40,000 acres per year, which would be an outlay of about £290,000 annually—a small sum, it will be admitted when compared with the £25,000,000 yearly expended by this country on supplies brought from abroad. In a future paper the cost of planting and financial returns therefrom will be dealt with.—[*Country Life*.]

POISONOUS BERRIES.

BY E. M. HOLMES, F.L.S.

The berries of the yew, *Taxus baccata*, Linn., are abundant at this time of year in calcareous districts, or wherever else the tree occurs. A great deal of misconception attaches to the poisonous character of the yew. Some writers have supposed that the poisonous character depends upon whether the leaves of the female or male tree are used, others as to whether the fresh or withered leaves are eaten; some have stated that the berries are poisonous, and others that they are not. The facts of the case are, that yew trees, both male and female, leaves and fruit, all contain the alkaloid taxine, which is distinctly a heart poison, and that the leaves are fatal to animals if taken under certain conditions, such as when the animal is famished, or is otherwise in a fasting condition. But when mixed with a sufficient proportion of food, although



YEW BERRIES (*Taxus baccata*, Linn.)

poisonous, these do not prove fatal; this was proved many years ago by administering yew leaves distributed in varying quantities of fodder.

The fruit consists of a fleshy, bright red, cup-shaped arillus, which has a sweet taste and is filled with a very viscid juice. The single seed is ovate, and it is the kernel which contains the poison, taxine; from this the viscid juice of the aril is free. The red, fleshy part is, in fact, often eaten by children, and so long as they eject the seeds there is no danger. It is also greedily sought by wasps, and even caterpillars, while birds are very fond of the fruits, the seeds being passed through their intestines unbroken. The berries of the yew can therefore only be considered poisonous if the seeds are cracked and swallowed.

From a purely botanical standpoint the yew "berry," as it is popularly called, is of some interest, since it is difficult to classify. In the vague sense that part of it is edible, it may be called a fruit, but it cannot well be classified under fruits, since it consists of a half-naked seed enclosed on one side with a fleshy aril. Its manner of fertilisation is also interesting, since this is effected by wind-borne pollen, and as there is neither ovary nor stigma, the micropyle of the ovule has to answer the purpose of a stigma, and for this it exudes in spring time a minute drop of viscous liquid. In the spring the pollen is blown about in sulphur-like showers, and such grains as fall on the micropyle of the seed are afterwards, when this sticky drop shrinks in drying, carried inwards upon the embryo.

A very good figure of the seed and aril is given in Green's 'Manual of Botany,' ii., p. 179, fig. 934. Such an anomaly does the construction of this fruit present that, in former days, when it seemed to be the chief ambition of botanists to invent as many artificial botanical terms as possible, the name *Sphalerocarpium* (from two Greek words, one having the double meaning of slippery and, as a consequence, dangerous, and the other meaning a fruit) was given to this particular divergence from the ordinary type of gymnospermous fructification.—[*The Pharmaceutical Journal.*]

AMERICAN BIG TREES.

It is the sycamore that the prize contest of the American Genetic Association has shown to be the largest deciduous shade tree of the United States, and the specimen winning the award—growing at Worthington, Indiana—is 52 feet 3 inches in circumference and 150 feet high. Taller than this grows the yellow poplar, one in North Carolina being 198 feet high, with a circumference of 34 feet 6 inches. The sycamore, or American plane-tree or buttonwood, is widely distributed over the eastern half of the United States, and, besides having fine shape and growing rapidly, it offers great resistance to insects and fungi, with notable endurance of city smoke and vapours. Of trees bearing nuts, acorns being counted, the valley oak of California proved the largest, one in San Benito County having a girth of 37 feet 6 inches and a height of 125 feet. Of trees bearing nuts usually considered edible, the chestnut and the black walnut are largest; and a chestnut tree near Crestmont, N.C., is 33 feet 4 inches in circumference and 75 feet high. Other big trees brought to notice included the great elm at Wethersfield, Ct., 28 feet in circumference and 100 feet high; a sassafras at Horsham, Pa., with a girth of 15 feet 10 inches; and a white birch in Massachusetts with a girth of 12 feet 2 inches.—[*Capital.*]

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INCREMENT FELLINGS WITH SOME POSSIBLE APPLICATIONS TO THE CHIR PINE.

BY B. R. WOOD, I.F.S.

In the February number of the *Indian Forester* a very interesting article appeared from the pen of Mr. S. H. Howard, I.F.S., advocating the adoption of a standard classification for thinnings and increment fellings in India, and it is with a view to stimulating discussion of this subject rather than in any spirit of criticism that I venture to disagree with some of his remarks on "Increment fellings."

In the article cited it is stated, page 67, that "Increment Felling' is taken as being the German *Lichtungshieb*, and on page 69, referring to the increment felling, it is said, "The essential point, however, is *that a lasting interruption of the cover is created*......... It is therefore usually employed when some form of soil-protection wood is to be introduced, either artificially or naturally." The expression *Lichtungshieb* is, I believe, used by German foresters in two senses—(*a*) the sense in which it may

be translated increment felling, when it partakes of the nature of a thinning, and the trees taken out are classified under "Yield from thinnings" (*Vornutzung*), and (*b*) the sense in which it may be translated as being the combined operations of preparatory and seed-fellings. German foresters use the term in this sense frequently when speaking of the shelter wood because by this operation much increment (*Lichtungszuwachs*) is obtained, but the yield in these operations is invariably classified under final fellings (*Hauptnutzung*), and it seems to me that in the definition of "Increment felling" these two essentially different operations have been mixed up.

If it is intended to make a lasting interruption of the canopy, before regeneration operations are commenced, then it means that, as far as the principal crop is concerned, a certain amount of soil is to be rendered unproductive, and an underwood will not yield compensating value for this. The trend of recent thought in Germany, which was considerably strengthened by the publication of Wimmenauer's Yield Tables in 1912 is that, within limits, so long as none of the soil is unproductive, the same amount of increment is laid on, however many trees there are on the area, and *it follows from this that the fewer the trees the bigger* the timber. Hence to obtain the largest possible timber it is necessary to work down to the smallest possible basal area which will not render any of the soil unproductive, and this operation may be described as *Lichtungshieb* or increment felling. This has been done in Germany for most species, and it is found that with light-demanding species, Oak and Scots Pine that when doing this the resulting cover is so thin (not broken but thin) that it is necessary to introduce a soil-protection wood underneath.

From this we can say that the essential point is that we have the cover thin, but *not* broken, and that when this operation is carried out with light-demanding species, a soil protection wood has to be introduced beneath, not, as Mr. Howard put it, that the *Lichtungshieb* is adopted when it is intended to introduce a soil-protection wood. Martin in his "Forsteinrichtung"

which, I believe, is the acknowledged authority in Germany, 3rd edition, page 178, is very clear on this point. He says, "The degree of the "Lichtung" is governed by the fundamental principle that the growing space of the individual stems shall, usually, be gradually widened. The "Lichtung" shall scarcely differ from a thinning, the cover therefore shall be only slightly broken......... In order to keep the soil in good condition, "Lichtungs hiebe" which are not regeneration fellings (such as seed-fellings, fellings for light, fellings in shelter wood) must have a soil-protection wood introduced." *

I would, consequently, suggest that some other definition of increment fellings should be introduced, in which it is made clear that the essential point of the operation is very far removed indeed from making lasting breaks in the cover. A sanction of this nature in unskilled hands is fraught with great danger to the crop.

Mr. Howard also says that he does not consider there is any great likelihood of these fellings being adopted in India for some time. In this he is probably right, but at the same time there is certainly the *possibility* that they will be introduced and that they may prove an exceedingly valuable operation. Martin states that the value of these operations is that they give timber of a desired size under a shorter rotation, and beyond this they may well have a special application in India shortly.

Working-plans have been, and more very soon will be, undertaken to convert Chir and Deodar forest into normal even-aged high forest, and it is at least likely that in some cases the size of tree aimed at will be that size which yields the most profitable number of sleepers. In the present irregular condition of the forests, it is highly probable that the Periodic Yield will be taken out by area, and that certain sacrifices will be involved.

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* Was den Grad der Lichtung betrifft, so gilt der Grundsatz, dass der Wachsraum der einzelnen Stämme in der Regel allmählich erweitert wird. Die Lichtung soll sich der Durchforstung fast unmerklich anschliessen, der Schluss also nur Schwach unterbrochen wenden .... Zur Erhaltung eines guten Bodenzustandes, werden Lichtungshiebe, die nicht zugleich die verjungung einleiten (wie Besamungs Schlage, Lichtschläge, Schirmschläge) mit dem Unterbau verbunden.

In this case suppose we have Periodic Block I under regeneration, Blocks II and III will, on the whole, contain fairly old trees, but we are dealing with uneven-aged forest at present, and it is highly probable that there will be groups and patches of younger trees of fairly dense growth. Under ordinary thinnings these will, perhaps, not grow to such a size that on entering the first period they will yield the most profitable number of sleepers, but if the increment felling is adopted it is possible that they will do so. This possibility is surely at least worth considering.

Another point worth considering in connection with these increment fellings is that there is no great market for Chir timber outside sleepers. Consequently it is desirable to have the trees of such growth that the greatest possible proportion of their volume is convertible into sleepers. Here increment fellings can play an important *rôle* in two ways. The rotation under which the requisite girth can be obtained is shortened first of all. Secondly, not only is the increment laid on fewer trees with the result that each individual tree is bigger, but it is also laid differently on each individual tree. If the trees are grown in close canopy the bole tends to assume a cylindrical form, but if they are grown in open canopy the bole tends to assume conical form, that is, the greater amount of increment, instead of being spread more or less evenly over the whole length of the bole tends to be concentrated nearer the base of bole, that is, it is concentrated in that part of the tree from which the sleepers will be cut.

These remarks are, from the nature of the case, somewhat far-fetched and "in the air" at present, but they have been made more from the point of view of things that may occur, than from that of things which it is urgently necessary to discuss at once. At the same time the more these things are discussed now, the more Working plans Officers will have to go upon in the future when the time for such things does come.

SOME NOTES REGARDING THE HABITS OF *PTEROCARPUS MARSUPIUM* (BIJASAL, BIJA) IN CERTAIN LOCALITIES.

BY S. SHRINIVASULU NAYADU, EXTRA DEPUTY CONSERVATOR OF FORESTS, NAGPUR-WARDHA DIVISION, CENTRAL PROVINCES.

While inspecting coupe No. 1 of Felling Series VIII of the East Pench Range last year, I was struck with the marvellous amount of what appeared to be *bija* reproduction. The coupe was felled in 1912 13 under the system of coppice-with standards. It was open to heavy grazing for years till the completion of fellings but closed thereafter. Thus at the time of my inspection the area had been closed to grazing for two rainy seasons.

2. I at once jumped to the conclusion that the fellings by thoroughly isolating the *bija* standards made them bear good seed and that the ground being devoid of grass, owing to the heavy grazing, the seed reached the mineral soil and gave rise to the mass of seedlings noticed. The growth of grass was thin enough to shelter the seedlings, but as it would become more and more dense with every year's closure, I felt anxious whether the closure which, according to the Working-plan, had to go on for 13 more years would prove a blessing or not. I thought in fact that before long limited grazing would have to be allowed on the area. This idea may be still correct, but later observations have revealed some additional facts.

3. Nearly two thirds of the forests of the East Pench Range lies on gently undulating country and the remainder on rugged hilly ground, the soil and subsoil drainage therefore varying from fairly good to good. The formation is metamorphic, composed of gneiss, quartzite, mica schists, etc., which give rise to a variety of soils, pure sand, loam, clay, etc., with or without an admixture of fragments of crystalline rock. The subsoil is firm and not easily penetrated by roots of trees. The general elevation is 1,300 feet above sea level. The rainfall is 45 inches, confined mainly to the four monsoon months. The cold weather is short and hot weather severe. The coupe in question is situated on gently undulating ground and is well drained. The soil is composed of

sandy loam mixed with fragments of quartz and limestone and is very shallow.

4. The stock in the forests, taken as a whole, consists of a mixture of species, including teak and *bija*. The density varies according to the quality of the soil and situation but, generally speaking, it does not exceed ·8. In coupe No. 1 it was not more than ·5. In the Working-plan the proportion of teak is set down at 10 to 20 per cent. of the crop. *Bija* is, perhaps, even less. Whilst teak exists in groups or patches which admit of expansion, *bija* grows very scattered and consequently endeavours to increase the proportion of this species are bound to be diffused and therefore difficult. As *bija* fetches very little less than teak and is in as much request in the local markets as the latter, it is natural to wish to see its proportion materially increase in the new crop.

5. This may be taken as the justification for my boasting to my Conservator and other observers of the splendid results shown by the coupe in question. Very comforting though this was, I could not overlook the absence of advance growth which represented stages of growth between what appeared to be two-year old seedlings and the old trees, as without such advance growth regeneration cannot be said to be reliable in crops of mixed species and ages. I have also had experience of this disappointing feature in the case of some other species, *e.g.*, *Hardwickia binata* and *Terminalia tomentosa*.

6. An examination of some more exploited coupes this season showed the same results, *viz.*, plenty of young *bija* appearing to have come up since the closure without any marked differentiation in age. In the unexploited and therefore grazed areas such young growth was never in evidence except in small quantities under the protection of thorny bushes. Three causes, *viz.*, irregularity of seeding, injury from grazing and the nature of the species itself suggest themselves as having been at the root of this difference and the absence of progressive advance growth.

7. *Bija* is believed to be an annual seeder. The density of the tree-growth in which *bija* grows scattered is considered by some observers not to affect seeding. They hold that under the

Indian sun no tree, not even *bija*, needs as much opening up to bear seed as is given to standards in a coppice-with standards area. I am not quite a believer in this. It is true that most Indian woods in dry tracts do not present, as they stand, a greater density than European forests in which a seeding felling has taken place, but it does not follow that they do not require further opening up in order to produce a copious supply of good seed. The behaviour of certain species such as mohwa (*Bassia latifolia*), mango, nim (*Melia azadirachta*), etc., within our common knowledge, which blossom more profusely in dry than in moist years gives us a ready indication in favour of isolation of seed-bearers. During the current season I have inspected several miles of forest in the East Pench Range. I noticed very little fruiting of *bija* in unexploited Government forest whilst in Malguzari (private) forests where reckless felling had isolated the trees preserved for timber, and in Government exploited areas, *bija* was loaded with fruit. It is therefore certain that *bija* is peculiar in the matter of bearing seed when left to shift for itself in close contact with other species. The existence of seedlings, under bushes, in unexploited areas, however, shows that this irregularity of seeding could not have been a material impediment to the appearance of young growth, as some trees at least do seed every year and the light-winged fruit is wafted away far and wide.

8. Grazing in the unexploited areas which at present happens to be heavy is undoubtedly responsible to a certain extent but it does not explain all. It accounts for the absence of young *bija* in open places accessible to cattle, and the existence of seedlings under bushes. But how can the similarity in growth even among the individuals appearing under bushes be explained? Could it be that they are suppressed and therefore persist more or less looking alike? If this explanation is seriously urged, I need only refer to what I saw in another part of the forest to combat it.

About a fourth of the East Pench forests in the north western corner is left unworked for insufficiency of demand. This portion, particularly in the vicinity of the Pench river which forms the western boundary of the Range, has been protected from fire

and grazing for years—not less than 30 years. There are also, at any rate in the locality examined, no indications of frost or other injuries. Grass does exist, but it is not higher or denser than what was noticed in the coupe specified above. Even here, whether in the open or under lofty shade, young *bija* exists in a standstill form.

9. The suspicion thus centres on the last cause, *viz.*, the nature of the species which is to develop a long and stout tap root before beginning to make headway above ground. An examination of many individuals in various localities disclosed that the stem above ground remains either stationery or dies back several times, whilst the root is lengthening and increasing in thickness below ground. Plate 21 illustrates this characteristic.

Serial number in Plate 21.	Length of root below ground.	Height of stem above ground.	Explanations.
1	6′ 2′	6′ 0′	Six-year old *bija* found growing with mango and *nim* in a 5′ × 5 × 5′ pit in the Seminary Hill Plantation, Nagpur. Formation trap, pit filled with good soil, plants watered for the first four years and the soil kept well mulched and heaped up against the stem during the last two years. The individual had no set back, but the root has grown more than the stem. The last 1¼ feet of the root had flattened to work down the fissures in the rock below. The specimen would probably have grown into a healthy tree.
2	2′ 6′	6′ 6′	Specimens taken out of the forests in the coupe referred to in the note; tap-root conspicuous and fairly stout, lateral roots also developed at varying depths. Stems above ground appeared rigorous and likely to grow into healthy trees. Age not known.
3	2′ 6′	3′ 6′	
4	2′ 0′	5′ 6′	
5	2′ 4″	2′ 6′	Ditto; ends of tap-roots contorted and heavily scarred from contact with fragments of rock; stems weedy after repeated dying back, not likely to come to anything. Age not known.
6	2′ 5″	2′ 0′	
7	2′ 0″	1′ 6′	
8	1′ 9″	0′ 7′	

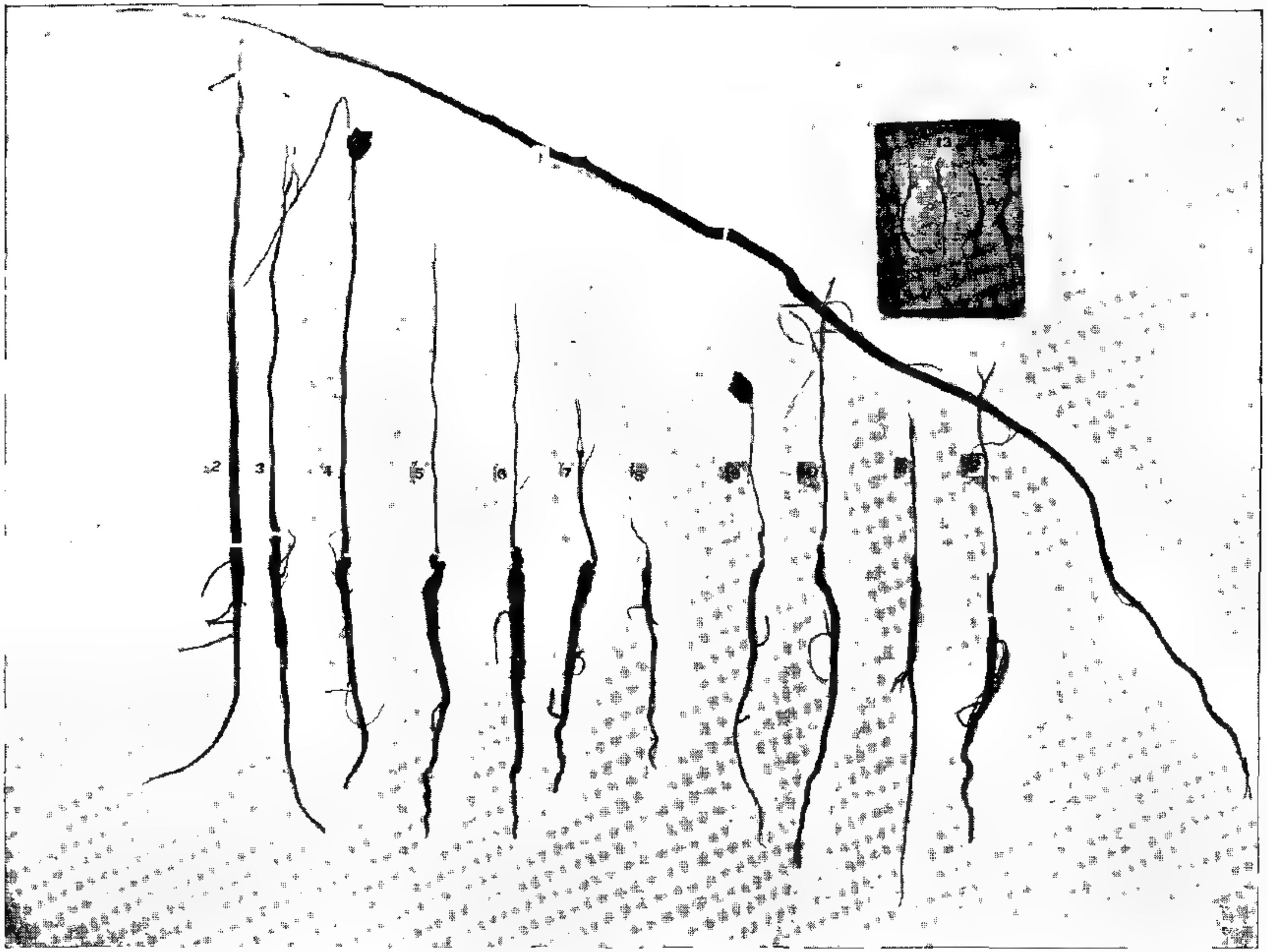


Photo.-engraved & printed at the Photo.-Mechl. & Litho. Dept., Thomason College, Roorkee

Habits of *Pterocarpus Marsupium* in certain localities.

Serial number in Plate 21.	Length of root below ground.	Height of stem above ground.	Explanations
9	2′ 4″	1′ 8″	Specimens taken out of the forests in the coupe referred to in the note; tap-roots still vigorous; Nos. 9 and 11 had not met with any obstruction and their stems, though weedy at present, seemed to have a future. The tap-roots of 10 and 21 are contorted and scarred fairly heavily. The future of the stems still doubtful. Age not known.
10	2 8	2′ 2	
11	2′ 8″	1′ 3″	
12	1′ 10″	2′ 2″	
13	0′ 7″ to 1′ 2″	0′ 3 to 0′ 8	Ditto; looked like the year's seedlings, but on examining the scars and knots at the base of the stems it was clear that the individuals must have been in the ground for at least five years.

NOTE.—The lines of junction of stem and root are marked by means of white rings.

10. It is therefore clear that most of the young stuff that has sprung up with the closure to grazing after exploitation, previously existed in the ground but had been kept down by grazing and that its survival and progress depend upon the amount of success with which the roots strengthen themselves sufficiently to enable the stems above ground to shoot ahead. For what length of time this process of preparation under ground must go on and in what manner that period could be shortened are points which are yet to be determined.

11. If even a third of the young growth could be brought through, the proportion of *bija* would be quadrupled. But if matters are left to nature, there seems to be very little hope of good results. The root-stocks may not ever get strong enough to send up anything more than weedy stems, *vide* Nos. 5 to 8 in the plate.

The experiment of loosening the ground as deeply as possible round these young individuals is being tried. It is probable that this measure will induce the development of lateral roots which' though not preventing the elongation of the tap-root, will greatly increase the vigour of the plant as a whole, *vide* Nos. 2 to 4.

THE BOARD OF FORESTRY

TRIENNIAL MEETING.

(*Reproduced from "Pioneer," dated 6th April* 1916)

The third triennial meeting of the Board of Forestry was held at Dehra Dun between the 23rd and 30th March, the members on this occasion being Messrs. G. S. Hart, C.I.E., Inspector-General of Forests; C. G. Rogers, Chief Conservator of Forests, Burma, M. Hill, C.I.E., Chief Conservator of Forests, Central Provinces; B. B. Osmaston, President, Forest Research Institute and College; P. H. Clutterbuck, Chief Conservator of Forests, United Provinces; T. R. D. Bell, Conservator of Forests, Bombay; P. M. Lushington, Conservator of Forests, Madras; H. H. Haines, Conservator of Forests, Bihar and Orissa; A. W Blunt, Conservator of Forests, Assam; R. McIntosh, Conservator of Forests, Punjab; Sir Henry Farrington, Conservator of Forests, Bengal; and Mr. R. S. Troup, Assistant Inspector-General of Forests. Unfortunately the Hon. Mr. C. H. A. Hill, Member of Council in the Department of Revenue and Agriculture, was unable to be present, but the Hon. Mr. R. A. Mant, Secretary to the Government of India in that Department, attended one meeting of the Board.

The Board of Forestry, which was first constituted in 1910 and meets triennially, exercises no executive control over the business of the Forest Department, but is purely an advisory body, one of its chief functions being to advise on the management and work of the Forest Research Institute and College, Dehra Dun. The present meeting of the Board is the first held since the completion of the new buildings at Dehra Dun, and the members were given an opportunity of inspecting the various museums and laboratories as well as the new quarters and mess-house now in course of erection for the students of the Provincial Service classes.

The proceedings commenced with an opening address by the Inspector-General of Forests. After referring to the utility of the Board meetings in bringing together senior officers of the service from all parts of India and to the effect of its meetings on research, education and general progress, Mr. Hart outlined the

results of the past three years and indicated the directions in which future progress is desirable. The questions considered by the Board were many and varied. The programme of research work for the next three years was approved, new rules and a revised syllabus for the Provincial Service course of instruction were passed, and other matters of a more or less routine nature were disposed of. Among more technical subjects the Board discussed an interesting note by Mr. Tireman, Deputy Conservator of Forests, Coorg, on the measures taken to deal with the Lantana pest in that province and notes on "The Necessity of a Systematic Study of Indian Forest Seedlings" by Mr. R. S. Hole, Forest Botanist, and "The Need for Systematic Record of Insect Damage and the Experimental Introduction of Control Measures" by Mr. C. F. C. Beeson, Forest Zoologist. Mr. Hole also read an interesting paper on "The Development of Sal Seedlings," while a note by Rao Bahadur S. Shrinivasulu Nayadu on "Proposals for the Training and Improvement of the Position of Forest Guards" contained some original suggestions for obtaining better work from the lower grades of the Forest Service A question of great importance to the future of forest work in India, namely, the development of Forest Engineering, was fully considered, and it is hoped that the steps advocated will result in a steady improvement in methods of extracting and transporting forest produce. But perhaps the most important question before the Board was that dealing with the preparation and control of Forest Working-plans, for on this the whole future management of the forests of India must depend. The question of improvement in systems of forest management, based on the results of scientific research, has received much attention in India within the past few years, and visible progress in the introduction of improved sylvicultural systems has been noticeable in certain provinces: much remains to be done in this direction, however, while as regards the quantity of work turned out matters are in a backward state owing to want of staff. The Board of Forestry will have done a good service to Government if its proposals result in material progress in the preparation of Working-plans.

INSPECTOR-GENERAL'S ADDRESS.

The following is the full text of the Inspector-General of Forests' opening address:—"The first thing I have to say is to express my sense of the honour that has fallen to my lot in presiding at the third meeting of the Board of Forestry. These triennial meetings of the Board bring together senior officers of the Service from all over India and apart altogether from formal discussions and resolutions the personal exchange of ideas between these officers is bound to be beneficial. I need fear no contradiction, therefore, if I say that the previous meetings of the Board have helped to promote the progress of Forestry in India and if I express the hope that our present gathering and those which follow from time to time will have equally good results.

"Next I have to state the regret which I am sure we all feel that the Hon. Mr. Claude Hill, Member in charge of the Department of Revenue and Agriculture, is unable to attend any of our meetings on this occasion. Mr. Hill has asked me to tell you that he would certainly have been here to-day had it not been impossible for him to leave Delhi at present. The Hon. Mr. Mant, Secretary to the Department, could not get away from Delhi either; but I hope he will be able to attend one of our meetings before we finish our work.

"I turn now, gentlemen, to a brief statement of the action taken on the resolutions passed at the last meeting of the Board. But as the orders of the Government of India on each of these resolutions were circulated and are known to all of us, I propose to refer only to the most important of the subjects dealt with. For the rest it will be sufficient to say that with small modifications the resolutions were generally accepted by the Government of India and have been acted on as far as possible.

"The recommendations made in favour of extending sylvicultural research were cordially commended by the Government of India to the consideration of Local Governments. It is understood that the principle of appointing provincial research officers has been accepted by all the major Local Governments, while in certain cases definite action has already been taken. In Burma a local

research officer has been employed for some time past, this appointment being filled from the existing cadre pending proposals for the reorganisation of the controlling staff in which it is understood provision will be made for more than one appointment of this class. In the United Provinces an appointment has actually been sanctioned, and although so far it has not been definitely filled arrangements have been made for the remeasurement of the sample plots established by the Research Institute, thus relieving the Sylviculturist of this work and making it possible for him to devote himself to other investigations. In Assam the recently sanctioned reorganisation includes a research appointment, while in the similar scheme for the province of Bihar and Orissa provision for a combined post for research and working-plans has been accepted. It is understood that the reorganisation schemes under consideration for Madras and the Punjab will include research posts, and there can be little question that the remaining provinces will follow this excellent lead as soon as it is possible for them to do so.

RAILWAY SLEEPERS.

"A great deal of work has been done during the last three years in connection with bringing treated sleepers of Indian timbers into more general use on the railways of India. First and foremost an agreement has been entered into between the United Provinces Government and the Railway Board, by which some 10½ lakhs of treated chir sleepers (*Pinus longifolia*) will be supplied to the North Western and the Oudh and Rohilkhand State Railways. Naturally the Department has met with some difficulties in working a new business on such an extensive scale as this: but I believe that most of these difficulties are now in a fair way of solution and that, apart altogether from the great influence this project may have in generally pushing the utilisation of our so-called inferior timbers for railway sleepers after impregnation, it is probable that it will be advantageous to the United Provinces in helping to dispose of the outturn of large areas of forests which it might not have been possible to get rid of otherwise, at any rate,

for a long time to come. Progress in other provinces has been hampered by the effects of the war, but although no definite agreements have been made as yet, it is more than probable that the re-establishment of normal conditions will be followed by the commencement of supplies of treated sleepers from the *Dipterocarp* forests of Assam, from the Andamans and from the spruce and silver fir forests of the Himalayas.

"Unfortunately it has not been possible to make such progress as regards the introduction on the market of tan extracts. But the Government of India have now at last succeeded in obtaining the services of an expert from England, and this officer will very shortly commence his work on the manufacture of tan extracts on a commercial scale in the mangrove forests of Burma. It is hoped that when this work is completed the expert, who is bringing a portable plant from England, will be able to turn his attention to the manufacture of extracts from myrabolans, babul bark and other raw products which occur commonly in Indian forests.

"Again no definite action has been taken regarding the destructive distillation of wood. The Forest Economist has been unable to devote much attention to this subject and the information which we have regarding it does not yet seem to justify our asking the Government of India to employ an expert with the object of making a start on a commercial scale. No doubt this industry will come into being in the course of time, but owing to the great difficulty of disposing profitably of some of the products, more especially of the charcoal, I am afraid that it is not possible for the Forest Department to do very much in this matter at present.

"As regards the preparation of local forest floras the Government of India accepted generally the resolution passed by the last Board and expressed a hope that Local Governments would undertake the preparation of descriptive lists on the lines laid down by the Forest Botanist. It is satisfactory to be able to state that work in connection with the important matter is in progress in most provinces, in one or more of which special officers have been employed in their preparation.

THYMOL AND SALICYLIC ACID.

"These are only a few of the many directions in which the officers of the Research Institute have been active. Time prevents me from giving you many details, but I can assure you that much of the work done cannot fail to have considerable influence on commercial development in India. We have heard a good deal lately on the subject of capturing trade which has until recently been largely or entirely in the hands of our enemies. In this connection I may mention two important products with the experimental preparation of which the Chemical Adviser to the Institute has been intimately concerned, namely, thymol and salicylic acid. The manufacture of these products, which as you know, are of great importance in medicine, has hitherto been almost exclusively in the hands of the Germans. Preliminary experiments in the manufacture of thymol carried out in February 1915 in the chemical laboratory of the Forest Research Institute demonstrated the practicability of undertaking its manufacture on a commercial scale, and two months later the Dixon Chemical Company established a factory at Dehra Dun which is now turning out regular supplies of thymol of excellent quality from 'ajowan' seeds. This Company is now not only supplying the Indian demand, but is exporting large quantities of thymol to England and America. The preparation of oil of wintergreen and salicylic acid from the leaves of *Gaultheria fragrantissima* has also been taken up experimentally at the Institute; from the oil of wintergreen natural salicylic acid, natural sodium salicylate and aspirin have been made and so favourably reported on that the Dixon Chemical Company has decided to undertake the manufacture of these drugs on a commercial scale. It is of great interest, not only to ourselves, but to the general public, that the Forest Research Institute is thus doing its share in turning out important products hitherto almost exclusively of German manufacture and in promoting self support within the British Empire.

"Practical measures in connection with the eradication of lantana have now been carried out to a considerable extent in Coorg where special legislation in the form of the Coorg Noxious

Weeds Regulation has been enacted, where a scheme has been prepared to cover all the forests affected and where some Rs. 70,000 have been spent in the eradication of this pest over approximately 15,000 acres of forest. This scheme has not yet been finally sanctioned, but I think it may be taken for granted that there is no intention of dropping this work, and that it will be steadily prosecuted until all the forest areas in this small province have been freed. When we come to the discussion of Mr. Tireman's paper on this subject, our friends from Bombay and Madras will be able to tell us what action has been taken in their provinces to deal with the lantana and prickly-pear problems.

REORGANISATION SCHEMES.

"Outside the subjects referred to in the resolutions passed by the last Board of Forestry there are a few other matters on which action has been taken during the last three years to which I may make a brief reference. Firstly, there is the question of strengthening the staff of the Imperial and Provincial Service officers. Reorganisations have been sanctioned for the United Provinces, for Assam and for Bihar and Orissa; these with the creation of Chief Conservatorships for Bombay and the United Provinces, with the addition, either permanently or temporarily, of a fourth Conservator for Madras and a third Conservator for the United Provinces and with the sanctioning of posts of Assistants to the Botanist and Ecomonist at the Research Institute, have resulted in raising the strength of the Imperial and Provincial Services from 213 and 207 on the 31st March 1913 to 237 and 231 at the present time. It is known, too, that the Governments of Burma, Madras and the Punjab have reorganisation schemes under consideration, which may result in further additions to the number of Conservators and in a considerable increase to the strength of the Imperial and Provincial Services. It is hoped that Madras, also, will soon have a Chief Conservator, while in addition to the provinces I have just mentioned, it is possible that at least one other Local Government will soon have to consider a scheme for the reorganisation of its forest staff. It is probable, therefore, that the next three years will show still greater progress

in the matter than has been achieved since the Board met last. I mention this subject because we all know how woefully understaffed the Department really is and how extremely important accessions to our strength are for further progress.

"In the second place I should like to say a few words about the Research Institute and the Provincial Service class. The main buildings of the Institute have now been finished, and though there is still some work to be done in completing the exhibits in the museums, I am sure we all agree that we now have a well-equipped Institute with all the necessary laboratories and appliances. Apart from the buildings actually connected with the Institute, we have now in course of erection five fine blocks of quarters and a mess-house for the Provincial Service students, all located in an estate adjoining the Institute, which has been purchased by the Government of India and which contains ample space for playing fields and for such further extension as may hereafter be necessary.

Closely connected with this is the question of decentralising the training of Forest Rangers. This question was re-opened in 1914, as it was found that the classes in the Rangers' College were too large for really efficient training by the present staff and as it was held that matters had advanced to a stage at which the Government of India ought to confine itself to the training of candidates for the Provincial Forest Service leaving the training of Ranger students to the Local Governments concerned. A final decision on this question has not yet been arrived at: but I think it is probable that when the Board of Forestry next meets the Rangers' College at Dehra Dun will have closed, or at any rate be on the point of closing as an Imperial institution, its place being taken by provincial colleges.

"Another important matter to which much attention has been devoted and which has recently come into prominent notice in the Press is the manufacture of paper-pulp in India from bamboos, forest grass and timber. Much work in this connection has been done by Mr. Raitt, who is still retained as an adviser to the Research Institute, and by the Forest Economist. The war has prevented

operations being actually started, but several concessions have been granted by Local Governments and I think there is little or no doubt that this industry, which may ultimately attain very large proportions, will be commenced as soon as trade conditions render this possible.

"A GREAT FUTURE AHEAD."

"This brief sketch of our work during the past three years is sufficient to show that we have made some little progress. I regard the advance made towards the institution of sylvicultural research in the major provinces as particularly gratifying, for I am sure this will have far-reaching effects on the development of Forestry in India and on the general status and importance of the Forest Department. Though the Department is now in a very different position to that which it occupied 30 years ago, I am convinced that we are still hardly more than just past the beginning and that the Forest Service in India has a very great future ahead of it. Apart from the development of new industries, I believe that this future must be closely connected with the introduction of improved systems of management, based on the results of scientific research, both botanical and sylvicultural, and aided by the extended use of mechanical means of transporting and handling forest produce. We cannot perhaps expect that the surplus revenue which the service makes for the State will continue to increase in the same proportion as it has in the past, for in the last 50 years this surplus has risen by no less than 1,000 per cent. But we can at least be certain of two things. One that a decade or two hence the forests of India will have proved themselves of far greater value as producers of revenue than they are at present. The other that the rate at which this progress takes place will depend almost entirely on the extent to which the Government of India and the various Local Governments are willing to incur expenditure on improvements in communications, on special means for the extraction, conversion and transport of forest produce, on the commencement of new forest industries, and last, but by no means least, on the expansion of the trained staff.

"Gentlemen, I cannot close these remarks without expressing my regret that Mr Mercer was unable to postpone his departure on leave until after the close of this meeting of the Board of Forestry. Throughout the eight years which he spent as President of the Research Institute and College, Mr. Mercer made the interests of these institutions his special care and the many improvements which have taken place during this period are largely due to his energy and foresight; but during the last year or two his health has been far from good and this, combined with the pressure of personal business, compelled him to go on leave in the early portion of this month. As his successor we welcome Mr. Osmaston whose experience of forest work in many parts of India and whose well-known interest in the scientific side of our profession are guarantees of future progress."

PRIZE-DAY AT THE FOREST COLLEGE, DEHRA DUN (RANGERS CLASS).

The annual distribution of prizes took place on the 31st March at 4 P.M. in the afternoon, as usual on the College grounds. Besides Mr. Hart, the Inspector-General of Forests who presided and Mr. Osmaston, the new President of the Forest Research Institute and College, there were on the platform some of the distinguished members of the Board of Forestry and the Officers of the Forest Research Institute and College. The most noticeable change was the absence of Mr. L. Mercer, the late President of the Forest Research Institute and College, who had just retired.

Mr. Osmaston opened the proceedings by reading the annual report which we reproduce below. -

"MR. HART, GENTLEMEN, -With your permission I will proceed to read to you the report on the students of the Ranger Class who are about to leave the College.

"The report is necessarily a short one, as having only just arrived I am naturally not conversant with what has been going on

for the past two years. I am thus indebted to Mr. Mercer for the greater portion of my remarks.

"The Rangers Class now passing out showed at first a decided lack of promise, in fact at the end of the first year it appeared to be distinctly below the average. Mr. Mercer states, however, that in his eight years' experience he has never known a class improve to the extent that this one has done during their last year, due to hard and sustained work, and that he has little doubt that it is up to the average of former years, and this is more than borne out by the result of the examinations.

"In April 1914, 37 students joined. Of these one died, one resigned and one was dismissed, the number now remaining in the class being 34.

"As a result of the examinations seven students have been awarded Honours, 23 the Higher Standard Certificate and four the Lower Standard Certificate.

"For the greater part of the last year the class has been considerably handicapped by the absence of an instructor, no one being available to replace Mr. Donald who has joined the Indian Army Reserve. This has thrown more work on the Assistant Instructor, Mr. Wrafter, and the late President has asked me to place on record his thanks to Mr. Wrafter for the very efficient manner in which he has coped with the work that has thus devolved upon him.

"Mr. Wood, who was temporarily lent by the United Provinces as Instructor for some three months, ably lectured on Engineering, in which subject he also conducted the final examination. I am glad to be able to report that his services have been placed at the disposal of the College for a further indefinite period.

"In Mr. Wimbush and Mr. Das the College has methodical and careful lecturers, who have no doubt been largely responsible for the improvement shown by the class as a whole, while the departure of Mr. Donald has left a blank which will not easily be filled. The conduct and discipline of the students as a whole have been of a high order, but I regret to have to report that a student was detected trying to obtain unfair assistance in the final

examinations. He has been dismissed, and it is hoped for the honour of the College that there will be no repetition in the future of such dishonest practices.

"The health of the students has been good, though at times during last rains temporary absence owing to sickness and fever was inevitable, the season not having been a healthy one.

"Considerable keenness has been shown in sports and games, though in individual instances a want of punctuality in turning up was apparent.

"The Inspector-General's Cup for the best all-round athlete, one of the most valuable prizes of the year, has been awarded to R. Mitchell of the Provincial Forest Class. The award has been made on the result of the athletic sports combined with proficiency in games.

"The pressure on the Rangers Class continues, and it is impossible to make room for all the candidates that wish to join. It is true that the class is not so large as formerly, but it is still too large and the scheme for training Rangers in their Provinces which, it is understood, is now before the Government of India will, if passed, allow of many more men being trained annually, while they will get their training in localities in which they will afterwards be employed. Mr. Mercer urged this eight years ago, when he first came here, and his opinion is still unaltered.

"The thanks of the President are due to the staff of the Research Institute and College as also to the Forest Officers of the United Provinces who have given valuable and ungrudging assistance to the classes on tour. I would also convey our thanks to the Superintendent of the Trigonometrical Survey for having kindly lent the services of Mr. West to conduct the final Survey Examination."

The following students have obtained the various certificates :—

Honours Certificates.

1. Dhan Raj Datta (C. P., Berar)
2. Amrit Lal Banerji (Bihar and Orissa).
3. Malhar Trimbak Mahagavker (Baroda State).
4. Arthur Hensman (Ceylon).
5. Dadabhoy Pestonji Veerjee (Bombay).
6. Mul Chand Minhotra (Punjab).
7. Sultan Muhammad Khan (Punjab).

Higher Standard Certificates.

8. Durga Datt Sanwal (U. P.)
9. Amar Nath Bhambari (Punjab)
10. Kawasha Sorabji Patel (Bombay).
11. Dalip Singh Bisht (U. P.).
12. Bijay Kumar Bhattacharji (Bengal).
13. Sorabji Rustomji Daver (C. P.).
14. Abdul Hafiz (Bombay).
15. Jaswant Rai (Private)
16. Amulya Chandra Biswas (Bengal).
17. Bhai Charan Das (C. P., Berar)
18. Didar Singh (Punjab).
19. Nazir Ahmed (U. P.).
20. Dina Nath Gandhee (Kashmir State).
21. Syed Zawwar Hasain (C. P., Berar).
22. Shishir Kumar Dutt (C. P.).
23. Karim Baksh (Punjab).
24. Balaki Das (U. P.).
25. Chandi Das Puri (Chamba State).
26. Rabi Dutta Juyal (U. P.).
27. Bishambar Datt Pant (U. P.)
28. Mohamed Abbas Ali Chaudhri (Assam).
29. Shankar Dattatrya Nesarikar (Bombay).
30. Nimish Chandra Nandy (Assam).

Lower Standard Certificates.

31. Harsewak Rai (C. P.)
32. Sohan Singh (Bilaspur State).
33. Upendra Kumar Khasnobis (Bengal).
34. Dhirendra Chandra Gupta (Assam).

Mr. Osmaston then distributed the Honours and Higher Standard Certificates and Mr. Hart gave away the medals and prizes as follows :—

Gold medals for Honours men—

1. Dhan Raj Datta.
2. Amrit Lal Banerji.
3. Malhar Trimbak Mahagavker.
4. Arthur Hensman.
5. Dadabhoy Pestonji Veerjee.
6. Mul Chand Minhotra.
7. Sultan Muhammad Khan.

Silver Medals—

The best student of the year ...	Mul Chand Minhotra.
,, ,, in Forestry ...	Dhan Raj Datta.
,, ,, in Botany ...	Amrit Lal Banerji.
,, ,, in Forest Engineering	Dhan Raj Datta.
The McDonnel Memorial Medal (best all-round student from Punjab and Kashmir)	Mul Chand Minhotra.
The Fernandez Memorial Medal (best in Utilisation)	Dhan Raj Datta.
The William Prothero Thomas Memorial Prize (Practical Forester) ...	Arthur Hensman.
"Indian Forester" Prize (best student who has not received any other prize) ...	Malhar Trimbak Mahagavker.
Inspector-General's Prize (for athletics and sports) open to students of the Provincial Service and Ranger Classes ...	Provincial Service Class student R. Mitchell.
The Brandis Prize	(Not awarded).

Mr. Hart then addressed the students in the following words:—

"OUTGOING STUDENTS OF THE RANGER CLASS,—I am very pleased to hear the good account which Mr. Osmaston has given of your work and conduct during the course of your training, though I regret to learn that the President was obliged to dismiss one man belonging to your year for the dishonourable practice of cribbing at the final examinations. This is the first occurrence of this kind which I have heard of at Dehra, and I trust that the general sense of honour among the students will make it the last. I am sorry, too, to learn that some of you have been slack in turning up at the sports and games, for slackness of this sort often means subsequent slackness in carrying out work of the kind the Forest Officer has to do.

"The fact that seven men out of 34, or just over 20 per cent. of the class, have obtained the Honours Certificate is satisfactory evidence of the manner in which some of you have applied yourselves to your studies and the lucky recipients of the valuable gold medals have every reason to be pleased with themselves. On the other hand it seems to me to be possible that the larger percentage of Honours Certificates, which has been gained during recent years, may mean that it is easier to get a certificate of this class now than it used to be. An Honours Certificate should always be a real distinction, and it is possible that to ensure this it may be necessary to raise the standard.

"You have now completed your training and will shortly return to your provinces to start work in the Forest Service I want you to realise that although you may have learnt a great deal during the two years you have been at Dehra, you have a great deal more to learn before you can become really efficient Forest Officers. I want you all to realise also that Rangers form the backbone of Forest Administration, and to make up your minds that if you do fail to make good Range Officers it shall not be for want of trying. If you do not know it already you will, I am sure, be glad to hear that steps have at last been taken in most provinces to raise the pay of the ranger grades, and that although financial stringency may prevent the proposed improvements being brought into force

at once, you may be fairly certain that it will be your own fault if most of you do not eventually rise to the 200 rupee grade. On the other hand I must warn you against starting your service with the idea that in a few years' time you are likely to rise to the Provincial Service. The door of entry to that service is not closed to you, but except as an occasional reward for long and meritorious service towards the end of a man's career it is open only to those of you who may prove themselves to be exceptionally able and efficient. Any of you who may fulfil these requirements may, perhaps, hope to become Extra Assistant Conservators, but the main avenue of entry to the Provincial Service is through the special Provincial Service class.

"As you all know Mr Mercer relinquished the post of President of Research Institute and College early in this month. During the eight years he spent at Dehra Mr. Mercer never allowed his work at the Research Institute to interfere in any way with the care he exercised over the control of the College affairs and over the individual welfare of the students. He has been succeeded by Mr. Osmaston who, many years ago, was an Instructor at the School as it was then termed and who will certainly continue Mr. Mercer's care of the interest of the College so long as it may remain under his control.

"I wish you success in the forest services of your provinces, and I hope that you will always look back with pleasure on the time you have spent in this College, and that you will remember with gratitude the attention and care devoted to your training by the President and by your Instructors."

The proceedings were brought to a close by students giving cheers for the Inspector-General of Forests, the President and Officers of the Forest Research Institute and College.

NOTE ON FOREST SURVEYING WITH VERNER'S SKETCHING BOARD.

BY W. H. CRADDOCK, P.F.S.

(1) *Preliminary.*—The complete survey of a country even on so small a scale as $\frac{1}{4}'' = 1$ mile is a tedious if not an arduous undertaking especially of a region recently annexed Usually the surveyor has nothing to help him but crude native maps. If he be lucky he may have at his disposal Military Intelligence maps with triangulations for heliography, surveys of main routes and perhaps time and compass surveys of streams which are navigable for boats. The triangulations, rough though they may be, are useful as they locate the main peaks with pretty fair accuracy and give the surveyor some known points to hang his work on. It is quite possible he may have to be content with a triangulation of his own with, say, a 4" or 5" prismatic compass. Theodolite accuracy for surveys by Forest Officers is seldom, if ever, necessary or indeed practicable. The other rough surveys mentioned also help, for they direct the attention to prominent or interesting features and very often furnish valuable data in compiling the map for, after all, a map like any other work of reference must pass through several editions before it can be brought up to date and claim to be perfect.

For the earliest reserves in Upper Burma dating back some 20–25 years a good deal of useful, and I may add remarkably accurate, surveying was carried out by Forest Officers with the plane-table, the direction being obtained by aligning on to a man shouting some 10 to 20 chains away and the distances measured with a 66-foot rope, suitable allowance being made for bends, etc. I shall not forget my initiation into this method of survey by my Divisional Officer, since retired as Conservator. I expected the traverse to pan out hopelessly wrong and was most agreeably surprised to find that the error in the circuit did not exceed 6 or 8 per cent.

My attention was first drawn to the Cavalry Sketching board so far back as 1898, and I may say that since 1900 I have invariably used it for survey work in preference to the cumbrous plane-table, and with perfectly satisfactory results.

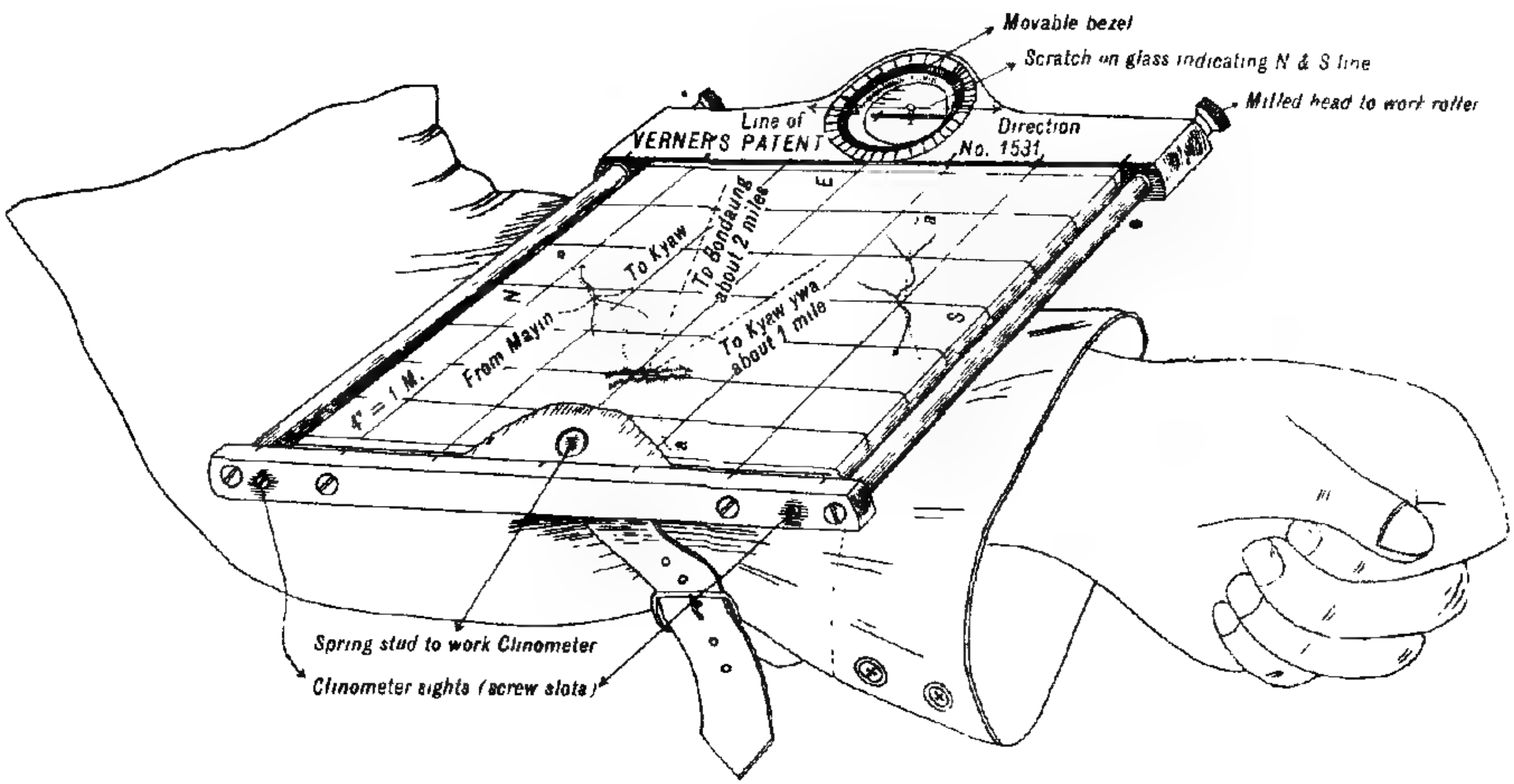
(2) *Description.*—The Sketching board—*vide* diagram (Plate 22)—consists of a well-seasoned board $5\frac{1}{2}' \times 7\frac{1}{2}''$ with boxwood strips fixed to the shorter sides and brass rollers fixed in the ends of these parallel with the longer sides and suitably near them to allow of the paper on which the survey is done to be rolled up as required The boxwood strips are furnished with various scales, and in the wider strip is sunk, flush with the board, a magnetic compass about an inch in diameter with a movable bevel (or rim) having a glass with a diametrical scratch. The bevel has a projection at one end of the scratch which serves the double purpose of revolving it and also of marking the North end of the scratch. Concentric with the compass on the boxwood are 10° gradations with a line marked "Line of direction" which runs parallel to the length of the paper. Near the middle of the opposite edge of the board is a counter-sunk spring stud which works a clinometer at the back of the board. This clinometer consists of a bevelled and graduated semi-circular boxwood arc, a weighted strip of brass hung radially from the end of the aforesaid spring stud serving as an indicator. Sight is taken through two screw slots one at each end of the boxwood edge, at the same time the spring stud is pressed, this causes the indicator to oscillate, and when the oscillations cease pressure is taken off the stud thereby clamping the indicator and enabling the angle to be read off. The clinometer is useful for measuring the angles of slopes, and if need be the height of a tree may also be measured by its means.

Pivoted to the back is a leather strap to fasten the board on the left wrist of the surveyor. So much for the Sketching board. A flat bevelled scale $12 \times 1\frac{1}{4}''$ (one divided into fortieths of an inch is most useful) with a couple of elastic bands to keep it on the board, a well-pointed hard pencil HH. or harder and a 67-foot stout boat line (the extra foot being an allowance for chaining) with ten split bamboo "arrows as white and conspicuous as possible for chaining, complete the outfit.

There are other patterns of Sketching board, some simpler and cheaper than that described and also an improved pattern known as the "Stanley-Hodgson," which has the compass mounted in the

SKETCHING BOARD.

Scale, roughly $\frac{1}{3}$th.



centre of the board for use with semi-transparent paper and a cleverly contrived sight-vane, or alidade, enabling sights to be taken by means of a hinged mirror.

(3) *Method of use.*—The N. and S. scratch line on the compass glass should be made to coincide with the "Line of direction." This obviates the necessity of laying off parallels and ensures the magnetic meridian always being parallel with the edge (length) of the paper. The paper should preferably be sectional, say 1 inch into tenths, though ordinary blank foolscap may be used after being ruled with 1 inch squares. The paper must be carefully cut and carefully inserted into the slits in the brass rollers and on being rolled should lie flat and not ruck up.

Before starting to survey, if the approximate direction of the line be known, a point should be fixed on the paper accordingly, otherwise fix a point somewhere near the middle. It is a good plan, if the area to be surveyed is at all extensive, to use as large a scale as one conveniently can and then reduce the day's work every evening on to a sheet of sectional paper, though if pushed for time reduction may be done away with and the scale used be that on which the map is ultimately to be, but the transfer to the sheet of sectional paper must invariably be made unless the area is so small that it is accommodated by the roll of paper on the Sketching board without running off the edges.

(4) *Example.*—Let us suppose we are working with a scale of 4" = 1 mile—using the flat bevelled scale divided into fortieths of an inch—which is convenient as each of the minor divisions represents half a chain. The chain-men must always keep 2 or 3 chains *ahead* of the surveyor and sights or rather shots are taken every two chains. In taking a shot the Sketching board is held level in the middle of the body with an edge or corner against the lower portion of the chest to steady it and is revolved on its pivot until the magnetic needle lies in the the same line or rather plane as the line scratched on the compass glass coinciding with the line of direction. The edge of the board is tapped slightly to ensure that the needle is free. The bevelled scale is then aimed at a chain-man two chains ahead (this can be

done sufficiently accurately without taking an actual sight). One edge rests with one of the minor divisions on the starting point—a pencil dot (it is not necessary to accentuate this with a pin as on a plane-table), and a pencil dot is made at the 4th minor division (*i.e.*, two chains) away from the starting point. Two chains further on this is repeated and so on. On the completion of ten chains, a small pencil tick is made as a check on the chaining and also to let the surveyor know the number of ten chain lengths he has traversed. In thick jungle the shots need be only a chain apart, while in open country long shots may be made, but it must be remembered that the longer the shot the more carefully must it be taken. In addition, shots should always be taken to prominent features as even though they may not come within the scope of the board they are a check on the work when transferred to a larger sheet map. As the survey proceeds, say the general direction is S. W. when the line comes ½" or so of the edge and is expected to run off the paper, the end should be marked with a distinguishing letter and a fresh starting point taken in line with and 4" or 6" to the E. and marked with the same distinguishing letter—*vide* diagram. Similarly, if the line goes off the paper in a south-easterly direction. If the direction is more or less due E. or W. the fresh starting point must be placed 4 due N. or S. of the end and 4' or 6" to the W. or E. as the case may be. The object of this spacing will at once be apparent. If sectional paper be used, the relative positions of these points in their respective squares should be the same. This plan saves much trouble when the survey is transferred, either reduced or on the same scale to the sheet of sectional paper which is to form the map ultimately. It will be seen that in this way quite a large traverse can be made on a single roll of paper and as much detail can be shown as is deemed necessary commensurate with the scale used. Whenever practicable, the traverse should form a circuit. Of course it is not to be expected that such circuits will close, but neither do they with the most careful plane-table work except by a fluke The error, however, if the survey be carefully done for forest maps, is negligible

and instead of the laborious process of distributing it, I have found that the following plan serves very well. Take the longest diameter of the circuit you can with the starting point at one end, cut the paper along this and either add or cut out the thin wedge occasioned by the error. Paste up and the circuit is complete.

(5) *Uses.*—For exploration and rough surveying the Sketching board is invaluable. Occasion should be taken to run traverses up to high peaks whenever time will permit, for there is no doubt that in the absence of maps, or even with them, a view from a commanding hill-top gives one a very good idea of the geography of a tract and also of the character of the forest growth. The main streams and other features may be easily picked out and roughly sketched in for quite a distance on either side of the traversed line and a very passable small scale topographical map may thus be made. [Both latitude and longitude may be roughly ascertained from "dead reckoning" of the line surveyed. It might be useful to remember here that the angle of elevation of the pole star gives a fairly close approximation to one's latitude. An eye should be kept on the magnetic variation, the true North being found by the pole star or sun's shadow method. The variation being known, incidentally local time may be approximately ascertained by taking the transit of the sun at noon with a prismatic compass.]

The measuring rope should be tested every day and always adjusted to 67 feet in length. In open country a route traverse of 15 miles or even more with a fair amount of detail can be done daily, and even in the most difficult country half a dozen miles a day can generally be done. The advantages of the Sketching board are its extreme portability and handiness, the speed with which ground can be covered and the small establishment required for the survey—two chain-men and an extra hand or two to cut one's way through jungle, carry food, etc., being all that the surveyor requires. Even single-handed with pacing, etc., quite useful work can be turned out, the instrument being primarily intended for military surveying single-handed on foot, horse or bicycle. It might be mentioned that in pacing those

blessed with long legs can with very little practice, easily pace 100 yards to within 1 or 2 per cent. Single paces should never be counted as it is a most tiring business but double paces or every fourth pace which comes quite easy when one gets into the rhythm. Those with shorter legs can use the military pace with a walking stick, each time the stick comes to the ground being reckoned as 10 feet = 4 paces. The unit of the scale used is not of vita importance so long as it can be reduced to a known quantity afterwards. A piece of stout note-paper or the convex portion of a piece of dry bamboo can be fashioned into a very fair straight-edge and scale if we remember that a half-penny or a pice measures an inch in diameter; and as for a hard pencil a pointed strip of lead or soft solder forms an efficient substitute.

For more precise work such as filling details in existing maps, surveying plantations and sample plots and for making linear valuation surveys, the Sketching board used according to the method described in para. 4 stands unrivalled.

A METHOD OF MARKING TREES IN ENUMERATIONS.

BY F. CANNING, I.F.S.

For enumerations the calliper with the measuring arm painted in various colours for the different girth classes is probably used everywhere in India. If greater accuracy is required, tapes similarly coloured can be used by almost any coolie. Some simple method of marking the measured trees is required so that unskilled labour may be used and the maximum amount of check may be made afterwards by an inspecting officer. The following method has recently been applied in Kumaon.

The implement used is the risser, with which grooves are cut in the bark of a tree. It is unnecessary to describe it as most Forest Officers are already acquainted with the implement. They are at present obtainable from the Canal Foundry, Roorkee. A certain number of horizontal or vertical grooves are cut in the bark with the risser, the particular number indicating the girth-class of the tree as measured by the calliper or tape.

Thus in enumerations at present being carried out in this division one horizontal groove is cut for trees between one and two feet girth, two horizontal grooves for two to three feet, three horizontal grooves for three to four feet, one vertical groove for four to five feet, etc. Over 1,000 acres of pine and oak forest have already been enumerated and the trees have been marked in this way. The method is very cheap and is quite within the capacity of a coolie. The marks will last a long time and combined with subdivision of the area to be enumerated into small plots, so that some of these can be completely checked by recounting, the method is proving very satisfactory. Chisel cuts can be made on the calliper corresponding to the marks cut by the risser on the trees.

No claim is put forward that the method described above is original, and this note is only written in the hope that it may possibly be of use to others, who like myself have not used this method before or who may have discarded the idea owing to difficulty in obtaining the implements.

SYSTEM OF SALE OF STANDING TREES IN KANARA FORESTS, BOMBAY PRESIDENCY.

BY E. M. HODGSON, I.F.S.

In connection with the article printed on pages 1 to 4 of the *Indian Forester* for January 1916, the following remarks might prove of interest. A great portion of the Kanara forests (Bombay Presidency) is High Forest with large teak and other timbers. Hitherto the trees have generally not been sold standing. Timber has been removed to depôts and sold there, payment being made in some form or other to a contractor for exploitation. Part of the above High Forest extends into the Belgaum Division as "Nagargali Series XIX." Until recently Nagargali timber was removed to a depôt for sale, payment being made for exploitation. All fuel and much useful timber was then wasted, while the Working-plan was usually two years in arrears because the only contractor available had other and far more important contracts in

Kanara. Three years ago a new plan was made by which all trees are sold standing. The contractors have now brought their work fairly up to date, and they remove *all* timber, besides utilising a good deal of fuel from the more accessible parts. Under the old plan the girth-limit for felling was 6 feet: under the new it is 7 feet. Formerly the revenue was Rs. 16,000 a year: but with the introduction of the new plan it has increased to, first year Rs. 35,000, second year Rs. 35,000, third year Rs 65,000.

These details help to support arguments in favour of the sale of trees standing; though the sale arrangement now working well in Belgaum would appear simpler than those advocated in the article quoted above.

FOREST FIRE "DON'TS."

To obtain the co-operation of the public in preventing forest fires which are doing a great deal of damage in the East this spring, the United States Forest Service has prepared ten "**Don'ts**" to be observed in the woods. It is hoped that these rules may have a beneficial effect during the fire season of the Southern Appalachians, which is not yet over, and that of the north woods, which is just beginning and which, from present indications, promises to be unusually severe.

Many thousands of acres of forest and suburban woodland from Maine to Florida, and from the Atlantic coast as far west as Arkansas, have been burned over already this spring by fires which started for the most part from preventable causes. On the National Forest purchase areas alone, forty-nine fires occurred in March burning over more than 6,500 acres, while forty-four fires starting on private land near or within Government boundaries damaged nearly 5,500 acres. Fires in April were even more numerous and severe, but rains in the latter part of the month helped the situation somewhat. Fire statistics for April are not yet available.

THE "DON'TS."

1. Don't throw your match away until you are sure it is out.
2. Don't drop cigarette or cigar butts until the glow is extinguished.

3. Don't knock out your pipe ashes while hot or where they will fall into dry leaves or other inflammable material.

4. Don't build a camp fire any larger than is absolutely necessary.

5. Don't build a fire against a tree, a log, or a stump, or anywhere but on bare soil.

6. Don't leave a fire until you are sure it is out; if necessary smother it with earth or water.

7. Don't burn brush or refuse in or near the woods if there is any chance that the fire may spread beyond your control, or that the wind may carry sparks where they would start a new fire.

8. Don't be any more careless with fire in the woods than you are with fire in your own home.

9. Don't be idle when you discover a fire in the woods; if you can't put it out yourself, get help. Where a Forest Guard, Ranger, or State Fire Warden can be reached, call him up on the nearest telephone you can find.

10. Don't forget that human thoughtlessness and negligence are the causes of more than half of the forest fires in this country, and that the smallest spark may start a conflagration that will result in loss of life and destruction of timber and young growth valuable not only for lumber but for their influence in helping to prevent flood, erosion, and drought.—[*The American Forestry.*]

SALVATION ARMY SILK CAMP IN CHANGA MANGA MULBERRY FOREST, NEAR LAHORE.

A MULBERRY FOREST.

Perhaps the only mulberry forest in the world is to be found at Changa Manga near Lahore. It is some 10,000 acres in extent, and has hitherto only been used for purposes of fuel and timber. It demonstrates that mulberry can be profitably grown by Government and private individuals for fuel and timber purposes, apart altogether from its great value in providing food for silkworms.

A SILK CAMP.

Some months ago Commissioner Booth Tucker asked the permission of the Punjab Government to take advantage of the

immense supply of foliage in this forest to establish an annual silk camp during the months of February and March for the rearing of silkworms on a large scale, with a view to popularising the industry throughout the Punjab and other parts of India, and in order to demonstrate the best methods for rearing silkworms.

His Honour the Lieutenant-Governor expressed his cordial approval of the scheme, and 5 acres have been assigned within the forest for the purposes of the silk camp

Operations were commenced early in January when a party was sent in advance to make the preliminary arrangements for erecting sheds and preparing accommodation for some two to three million silkworms.

As far back as May 1915 a supply of disease-free eggs of the best varieties had been ordered from Europe. They reached the Simla Silk School in October, and were there hibernated in a special machine provided for the purpose.

Hibernation of Eggs.

This important preparation for the silkworm industry is of recent introduction, but is an important link in the successful rearing of the best varieties. It helps to ensure a vigorous race of worms, who will produce cocoons rich in silk and also protects them from disease.

Hatching the Eggs.

This again is another important link. Special hatching machines of a simple pattern have been utilised by the Salvation Army during the last three or four years. The use of these and their value for hatching purposes will be demonstrated. They insure uniform heat, and enable the eggs to hatch out simultaneously, thus avoiding much trouble, delay and loss of eggs from chills.

Housing the Worms.

Different systems will be demonstrated in the silk camp. The two chief dangers to be guarded against are excessive heat and excessive cold, with violent variations between the two. The various systems will be demonstrated and the students, workers

and visitors will be allowed to judge for themselves which they consider best, or which will be most suitable for their own locality.

One large shed has been prepared on a system which guards both against cold and excessive heat. This has been introduced with great success at the Salvation Army silk farm in Moradabad. A trench is made about 100 feet long and 12 feet broad and 3 feet deep. The excavated earth makes a wall about 3 feet high, with a thick thatched roof, and a doorway at each end. In a dugout of this character worms have been successfully reared in the hot weather.

The Persian system of a shed on poles raised above ground, where the air can freely percolate all round and leaves can be stored underneath to get rid of extra moisture when there has been heavy rainfall, will also be demonstrated.

In Japan and in Europe it is usual to rear the silkworms on shelves, carefully arranged, tier on tier. This economises space and gives the worms the best individual care. In Kashmir and most parts of India, the worms are usually reared upon the ground, branchlets of mulberry twigs being heaped on top of each other. This ensures economy of labour, an important consideration. Instead of 6 or 7 feedings during the 24 hours, only two are necessary—morning and evening. The respective advantages of both systems will be demonstrated.

THE CAMP.

Besides the large sheds for the hatching of the worms, there are more than 50 tents for the accommodation of the workers and the staff, and for lectures and demonstrations. The camp is already a hive of industry, with about one hundred workers. It is intended to increase the number to 150 as the worms increase in size and need more attention.

VISITORS TO THE CAMP.

A good many distinguished visitors are expected. These will include His Honour Sir Michael O'Dwyer, the Lieutenant-Governor of the Punjab, and the newly appointed silk officer, Professor Maxwell Lefroy, who is conducting an investigation into the silk industry for the Government of India.—[*The Leader.*]

THE DYEING VALUES OF SOME INDIGENOUS DYE-STUFFS.

BY J. P. SRIVASTAVA, M.SC., TECH. ASSOC. M.S.T., ASSISTANT TECHNOLOGICAL CHEMIST, CAWNPORE.

Natural dye stuffs are perhaps not as bad as they have come to be regarded since their displacement by coal-tar colours. India boasted of a comparatively well-developed art of dyeing in the earliest stages of the historic period. The ancient Indian dyer could dye some very good colours with the help of colouring matters derived from the natural and mineral kingdoms. Some of these colours were fast in every sense of the word and answered all the requirements of the people for whom they were intended. This points to the possibility of valuable colouring matters lying unknown or forgotten in the forests and jungles of this country.

A large number of woods containing red and yellow colouring matters are still used even in Europe, but all these are obtained from America. There are undoubtedly similar woods in this country but no systematic investigation seems to have been made so far.

If America can find a market for so many dye-stuff extracts made from woods and other natural products, surely we with our vast, varied, and plentiful natural resources ought to have little difficulty in finding out and placing on the market similar products.

This question is of special importance at the present moment. The stoppage of the supply of German dye-stuffs has caused grave inconvenience in all colour-using industries. If Indian dye-stuffs had not been entirely discarded, the distress would not have been so acute. At least some part of the world's requirements would have been met by the dye-stuffs indigenous to this country.

Colouring matters are widely disseminated in the vegetable kingdom. Some one has said that any one who wishes to spin, dye and weave his own raw material at his own fireside need not go far afield for his colouring matters.

Such is indeed the case in a great many places where cottage industries still flourish. In Donegal, famous for its homespun tweeds, the colouring matters used are still mostly derived from

lichens and roots. The colouring matters of Donegal possess great fastness and beauty and their methods of application are alike novel and interesting.

I visited Donegal in December 1909 and submitted to the Secretary of State for India a report on the subject of the Cottage industries of the congested districts of Ireland. I have alluded in this report to the processes of dyeing used in Donegal.

The following investigation into the dyeing values of certain natural colouring matters still used by native dyers was undertaken under the orders of the Director of Industries, United Provinces.

The colouring matters were tried on wool and cotton by some of the more important methods of modern dyeing.

The methods employed were as follows :—

A.—ON WOOL.

(*a*) Dyed in an infusion of the colouring matter without the addition of any chemical or assistant to the dyebath.

(*b*) Dyed in an infusion of the colouring matter with the addition of 4% acetic acid.

(*c*) Dyed as in (*b*) and after treated in the same bath with 2% Pot. Bichromate.

(*d*) Dyed in an infusion of the colouring matter on wool which had been previously mordanted with Bichrome and Oxalic Acid

(*e*) Dyed in an infusion of the colouring matter on wool which had been previously mordanted with Aluminium Suphate and Tartar.

B.—ON COTTON

The Cotton *was steeped overnight in a decoction of myrabolans*, next morning it was taken out, squeezed and without washing worked in fresh baths containing the following :—

(*a*) Tartar Emetic

(*b*) Stannous Chloride.

(*c*) Alum.

(*d*) Ferrous Sulphate.

Generally speaking all the dye-stuffs described hereafter gave the most brilliant results on Stannous Chloride; Tartar Emetic and Alum coming after that. Ferrous Sulphate, as might be expected, dyed grey to black shades.

The inquiry has so far been prosecuted in regard to the following colouring matters :—

(1) HARSINGHAR (*Nyctanthes Arbor-tristis*).

The flowers of this tree contain a beautiful yellow colouring matter. The tree is found in abundance in the United Provinces, and when in bloom yields large numbers of flowers which generally open at night and fall to the ground in the morning. The flowers are collected, dried, and afterwards sold to dyers.

The colouring matter contained in the flowers is soluble in water, and also in alcohol. An extract can therefore be easily made.

Harsinghar gives brilliant yellow shades with all mordants on wool. On wool mordanted with Bichrome and Oxalic acid previous to dyeing a beautiful brown is obtained. The dyeings on wool possess good fastness to milling with soap and soda.

(2) TUN (*Cedrela Toona*).

This tree is said to occur largely in the sub Himalayan forests. The colouring matter is contained in the flowers which are dried and sold The principle constituent of the flowers is a yellow dye.

Tun dyes the best shade on wool in conjunction with mordant A(*d*). The dyeings on wool are, however, not very fast to milling with soap and soda.

(3) TESU OR DHAK (*Butea frondosa*).

This tree is found in abundance all over the United Provinces. The dye extracted from the flowers is still largely used by villagers for sprinkling on their persons as a mark of festivity at Holi festival, about which time the tree is in full bloom. The dried flowers are, however, available throughout the year. The flowers contain a yellow colouring matter.

Tesu dyes on wool shades varying from brown to dull crimson according to the mordant used.

The dyeings are fairly fast to milling.

(4) ARUSA *(Adhatoda Vasica).*

The leaves of this plant yield a yellow colour. Arusa is an evergreen plant and is found in the United Provinces. The colouring matter in Arusa is soluble in water and also in alcohol. The leaves contain a large amount of chlorophyl which is extracted along with the yellow colouring matter. The chlorophyl considerably dulls the dyeings obtained with Arusa. The yellow dye was separated by adding water to an alcoholic extract of the leaves. The chlorophyl was thereby thrown out of solution and the yellow colouring principle was obtained in the filtrate. This gave much better results in dyeing. On wool the best shade is obtained on chrome mordant A(*d*). The fastness of the dyeings on wool is fair.

(5) NASPAL OR POMEGRANATE RIND *(Punica Granatum).*

This plant is well known for its fruit. The rind of the fruit contains a tanning substance and also a yellow colouring matter, the latter in much smaller quantity than the former.

Pomegranate rind dyes very good shades varying from yellow to full brown on wool. All these possess very good fastness to milling.

(6) JANGLI NIL OR WILD INDIGO—*(Tephrosia purpurea).*

This is a small woody annual occurring in abundance in the United Provinces. It does not contain any substance yielding Indigo and its name "Jangli Nil" is probably due to its similarity to the Indigo plant.

Clarke and Banerjee have examined the constituents of the leaves of this plant. They found in it a colouring principle allied to quercetin or quercitrin (*vide* Trans. Chem. Soc., 1910, Vol. 97) Owing to the difficulty of separating the yellow principle from the chlorophyl efforts to obtain a pure yellow from *Tephrosia* have only been partly successful. The colouring matter is however, of great value, as it yields dyeings which are comparatively fast to light, washing and milling. The yellow principle was separated by extracting the dry leaves with alcohol, diluting the extract with

water and washing away the chlorophyl with petrol The purified colouring matter gave excellent shades of yellow in conjunction with various mordants. On account of the abundance of the plant it may be worth while devising a suitable process for extracting the yellow colouring principle. It would no doubt be very welcome wherever Fustic and quercitron bark are still in use. A decoction of the leaves of *Tephrosia* dyes wool mostly dull brown shades in conjunction with the various mordants, the most brilliant shade being that on Tin Mordant. The dyeings, however, possess very good fastness to milling.

(7) MAJITH (*Rubia cordifolia*).

The root and twigs of this plant contain a dye stuff identical with madder. Majith was largely used in this country before the advent of synthetic alizarine. Its cultivation has now, it seems, entirely gone out. It is at present greatly in demand all over India, but enquiries made so far have shown that it cannot be had in quantities large enough to meet the demand for it. It is undoubtedly one of the most valuable indigenous dye-stuffs. With its help red, maroon, and bordeaux shades of excellent fastness to light can be dyed on all fibres. It is the basis of a great many colours required by the calico-printers. The Farrukhabad calico-printers were at one time large users of this dye stuff and would be glad to go back to it if supplies were forthcoming. Majith as might be expected dyes very fast shades on both wool and cotton. The best results on cotton are obtained by using the Turkey Red process.

(8) CUTCH OR KATHA (*Acacia Catechu*).

The Catechu tree is found in several parts of India. An extract made by boiling the wood in water is still largely used in dyeing. Catechu is exported to Europe for use in dyeing and tanning Catechu may be applied to all fibres, though it is most largely used for dyeing cotton. The usual method of dyeing cotton consists in boiling the goods with an extract of catechu with the addition of copper sulphate, the weight of the copper salt

being 10 per cent. of the weight of the colouring matter. The goods are squeezed, allowed to stand for a short time, and then boiled in a fresh hot bath containing 2 per cent. bichromate of potash, washed and dried. Catechu brown is one of the fastest colours known.

(9) PATANG OR SAPPAN WOOD (*Caesalpinia Sappan*).

This tree is said to grow abundantly in Cuttack and in Central India It is a variety of the so-called Brazil wood which was once upon a time very largely used in dyeing in Europe. The colouring principle, *brasilin*, exists in a colourless condition in the freshly cut wood and is by oxidation converted into the true colouring matter *brasilein* The wood is similar in its composition to logwood. The oxidation of the colouring matter is carried out by a process of "ageing" in exactly the same way as logwood.

Patang is a valuable colour-yielding material. It can be used for producing brilliant shades of red, crimson and purple and is very suitable for calico-printing.

(10) LAC DYE.

This substance is of animal origin. It is the product of a small insect called *Coccus lacca* which lives on the twigs of certain trees such as *pipal* and *ber*. The incrustation produced by these insects on the twigs of the trees consists of (1) resinous matter, (2) colouring matter. The colouring matter is dissolved out by means of water or a weak alkali, the resin being left behind. The latter on melting and straining through canvas cloth constitutes *shellac*. The colouring matter is precipitated from its solution by means of alum and is afterwards pressed into cakes and sent out either for export or for sale locally.

Lac dye is manufactured largely in these Provinces, though like other natural products it has lost much of its former importance. Lac dye is dyed on wool chiefly on Tin mordant. It yields beautiful scarlet and crimson shades.

[NOTE.—In the above list accounts of dye stuffs from Turmeric, Safflower and Indigo, which are not forest plants, have been omitted.—HON. ED.]

CONCLUSIONS.

In the scope of this report it has been only possible to briefly allude to the dyeing values and properties of the various colouring matters examined. Exhaustive trials have already been made with all the above dye-stuffs in conjunction with various mordants on both wool and cotton. The dyeings obtained in each case have been tested for fastness to light, washing and milling. All these samples are being shown at the Exhibition of German and Austrian goods now open at the Upper India Chamber of Commerce, Cawnpore.

These samples have already attracted the attention of users of dye-stuffs who have visited the Exhibition and enquiries respecting them have been received from one or two places.

Surprising as it may appear at first sight, India's natural resources are capable of supplying dye-stuffs required for producing any colour.

The thirteen dye-stuffs described in the above note will enable a clever dyer to produce almost any colour.

We have in the list dye-stuffs yielding yellows, olives, browns, khakis, slates, greys, blacks, reds, scarlets, pinks and blues. Suitable combinations of these colours will give us almost any shade.

The fastness of many of these dye-stuffs is not so bad as one is often led to believe.

It must, however, be admitted that most of these dye-stuffs are not available to-day in large quantities and the prices are consequently prohibitive.

Cutch, lac dye and indigo are commercial products and may be had in fairly large quantities. Tun, Tesu, Arusa, Tephrosia occur wild and arrangements may easily be made for collecting them. Harsinghar and Naspal are not exactly wild products and so their collection will necessitate special arrangements being made.

Majith and Sappan wood are perhaps the most difficult to get at, and, so far as we have been able to gather, their cultivation has practically gone out, but an enquiry into the matter is still proceeding.

A systematic study of the properties and methods of application of these dye-stuffs would no doubt bring to light many valuable facts which would make the dye-stuffs more popular with the dyer

There is every likelihood of a great many more colouring matters being found in the forests of India but this would be a matter for the Forest Department to deal with.

The examination of indigenous dye materials has been continued in the Technical Laboratory at Cawnpore. A communication on this subject has already been made to Government. Since then some additional dye materials have been examined and the following is a brief account of their properties and methods of application in dyeing.

(1) *Bauhinia racemosa* (Kachnár).—This is a shrub very common in these Provinces The bark yields a red dye which is largely associated with tannin. The dye is not very bright, but nevertheless it may be employed for dyeing dull reds on cotton It may be dyed on cotton without the help of any mordant. Cotton seems to have an affinity for it. Faster results are obtained on alumina or tin mordant. Kachnar bark is said to be used in Burma for obtaining a dull black colour on cotton. For this purpose the cotton is dyed direct in an infusion of the bark and is then worked in mud whereby the dull red colour is changed into a black (*vide* note by Conservator of Forests, Eastern Circle, Burma, 1896). The bark can be had in any quantity and may be of service to tent manufacturers who require a dull red colour for the inside of tents.

(2) *Ficus religiosa* (Peepul).—The roots of this well-known plant were examined and found to contain a red dye which gives a good pink on cotton mordanted with alumina. The shade so obtained is fairly fast.

(3) *Pterocarpus santalinus* (Red Sanders wood) is a small tree occurring in Southern India. The wood yields a valuable red dye. It was largely used in dyeing before the advent of synthetic colours. The dye principle is called santalin. It was prepared in the laboratory in an impure state from an ethereal infusion of the

wood. The crystals deposited from the ethereal solution were further purified by washing them well with water, re-dissolving in alcohol, and precipitating with lead acetate. The precipitate was well washed with boiling alcohol and decomposed with sulphuric acid in the presence of alcohol, on removing the lead sulphate and concentrating the solution pure crystals of santalin were obtained. They melted at 103—105 C. (un-corr.).

Sanders wood dyes wool without any mordant. Very good shades of satisfactory fastness are obtained on cotton, on tin and alumina mordants. The dye does not dissolve in water though it is freely soluble in alcohol, ether and acetic acid.

(4) *Mallotus philippinensis* (Roli or Kamela Powder). This dye is obtained from a small tree found along the foot of the Himalayas and in Southern India. The fruits have red glands on the surface of the capsule and the powder is obtained by crushing or breaking up these glands. Kamela used to be largely employed for dyeing silk. It gives a beautiful yellow on silk mordanted with alumina. The shade obtained compares favourably with that dyed with Chrysophenine. The dyeing must be done in an alkaline bath.

(5) *Juglans regia* (Akhrot)—The bark yields a valuable brown dye. It is of special importance for wool at the present moment because it yields on this fibre a fast shade which may easily be modified to a khaki. A great many dye trials were made and as a result of these the following conclusions were arrived at :—

(a) The deepest shade is obtained by dyeing with an addition of 3 per cent. acetic acid to the dyebath. The fastness to light is, however, poor in this case.

(b) Fairly full shades were obtained on chrome—oxalic acid mordant or by the after-chroming process. Both these give dyeings of excellent fastness to light and milling. The poorest results both as regards depth of shade and fastness to light and milling were obtained when the dyeing was carried out with an addition of 15 per cent. Glauber's salt to the dyebath.

(6) *Artocarpus integrifolia* (Kathal). The wood yields a yellow dye which may be dyed on cotton on alumina mordant. The shades obtained are good and fast.

(7) *Rasaunt* (Barberry). The bark, roots and stem of this plant are rich in a very good yellow dye. This plant is plentiful in the Kumaun hills. The aqueous infusion of the bark and stem is used as a medicine for ophthalmia and is highly prized as such. The dye principle of Barberry is Berberine which is an alkaloid containing nitrogen. Berberine was prepared in a state of purity from Barberry by adding alcohol to the aqueous extract, whereby all foreign matter was precipitated. On concentrating the filtrate crystals of Berberine were obtained which were purified by re-crystallisation from water.

Rasaunt is used chiefly as a dye for silk. It was dyed on cotton mordanted with alumina but dull shades were obtained. This was perhaps due to the presence of chlorophyl in the preparation which came from Naini Tal.

(8) *Rhus Cotinus.*—The wood of this plant yields a dye similar to young Fustic. On cotton mordanted with alumina an orange yellow colour was obtained; with tin an orange red was obtained. The dyeings are, however, not fast to alkalis and soap.

TECHNICAL LABORATORY,
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ACKNOWLEDGMENT OF MR. MERCER'S SERVICES AS EDITOR OF THE *INDIAN FORESTER*.

In response to suggestions received we take this opportunity to record a hearty vote of thanks to Mr. Mercer for his very successful management of the *Indian Forester* for five years. In so doing we feel confident we are doing no more than expressing the sentiments of all members of the Indian Forest Service.

CHIEF FACTORS INFLUENCING THE DEVELOPMENT OF SAL SEEDLINGS.

BY R. S HOLE, I.F.S, FOREST BOTANIST.

(Paper read before the Board of Forestry at Dehra Dun, March 28th, 1916.)

1. In the case of research work extending over a series of years and comprising a large number of separate experiments, it is desirable to summarise the results from time to time and to briefly review the work as a whole. The various results can then be

seen in their proper perspective and the bearing of the work, as a whole, on the problems of practical forestry, appreciated. From past experience, also, it is believed that a short review of this kind will be acceptable to the members of the Board of Forestry who visit us but once in three years and who, therefore, can personally see only a small part of our experimental work at Dehra. The present paper consequently contains a summary of some of the chief results of the work recently carried out at Dehra Dun on the factors influencing the development of Sal (*Shorea robusta*) seedlings.

2. The seedling reproduction of *sal* in our Indian forests is by no means satisfactory. In many forests where conditions seem favourable no seedlings exist and in others the seedlings die back for several years. Fig. 1 (Plate 23) shows examples of *sal* seedlings which have died back for several years and which are typical of the majority of those found in the protected forests of N. India. Note the thickened root-stocks and comparatively feeble shoot development. This dying-back is usually considered to be due to drought. In such cases the whole plant dies annually, with the exception of the stout portion just below the ground-level which persists and gradually increases in size and length until, finally, a persistent aerial shoot is also developed. This delay in the establishment of seedlings interferes with the economic management of our forests and entails a financial sacrifice in the loss of several years' increment. Drought, however, obviously cannot explain why seedlings frequently die wholesale during the rains nor why the dying-back is frequently more marked in shady forest than in more exposed situations in the open.

3. The following results dealing with the causes of the death and dying-back of *sal* seedlings have now been established by work recently carried out at Dehra Dun :—

(*a*) Seedlings grown under favourable conditions of soil and moisture in the Dehra Dun garden do not, as a rule, die back. A few weakly individuals do die back, but the majority produce vigorous shoots which persist from the first and attain an average height of

Fig. 1.

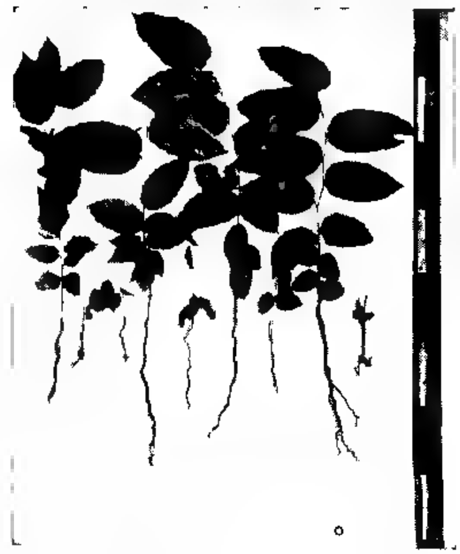

Fig. 2.

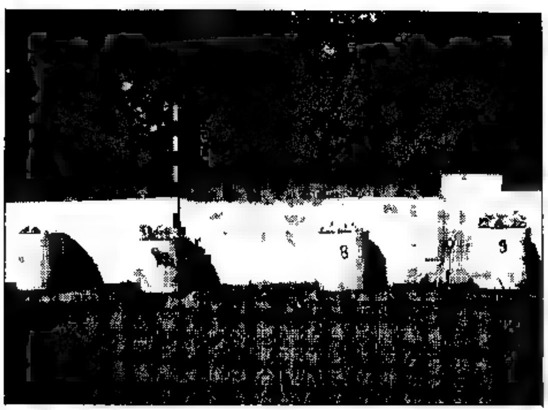

Fig. 3.

Fig. 4.

Fig. 1. *Sal* seedlings typical of those found in the protected Dehra Dun Forests. These have greatly thickened rootstocks and have died back for several years. The measuring staff appearing in this and the subsequent figures shows lengths of 6 inches, alternately black and white.

Fig. 2. *Sal* seedlings, 1-year-old, grown under favourable conditions of soil and moisture in Dehra Dun Experimental Garden. The 5 small plants have died back. The majority of the plants, however, do not die back under these conditions and the 4 large specimens are typical of these. Such vigorous plants attain an average height of 13·6 inches in 1 year and 26 inches in 2 years. This may be regarded as the ideal seedling development possible in this locality.

Fig. 3. Photograph taken September 20th, 1915, showing 1-year-old *sal* seedlings growing in *sal* forest loam. Note the healthy growth in the uncorked pots 7 and 9, as compared with that in pots 6 and 8 which were corked on July 30th, 1915.

Fig. 4. Photograph of shade plot XI taken on July 20th, 1915, 2 years after sowing. Note the absence of vigorous seedlings in the seed bed.

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13 inches in one year and 26 inches in two years. Fig. 2 (Plate 23) shows such seedlings 1-year old and also some weakly plants of the same age which have died back. These vigorous garden plants indicated the development which was possible under the local climatic conditions and the chief object of the present work was to attain or approach this ideal in the local forests.

(*b*) An experiment carried out in the Dehra Dun garden, in 1913, showed that if rain-water was allowed to accumulate in non-porous pots, in which the basal drainage holes were tightly corked and which were filled with the local *sal*-forest soil, the latter was soon rendered entirely unsuitable for the growth of *sal* seedlings, although it was by no means saturated with water. It was found that, under these conditions, 100 per cent. of *sal* seedlings were either killed or had their roots extensively rotted when the water free air-space in contact with their roots was maintained at 450 c. inches per c. ft. of soil, or less, for a period of six weeks, while seedlings in the same soil in similar pots but which were uncorked remained healthy. This experiment was repeated in 1915 with practically the same results. Fig. 3 (Plate 23) shows the appearance of the seedlings in these pots in September 1915. Note the healthy plants in the uncorked pots 7 and 9, as compared with those in the corked pots 6 and 8. This experiment, therefore, showed that the mere retention of rain-water for some weeks in contact with a *sal*-forest loam is sufficient to render the latter unsuitable for the growth of *sal* seedlings. In this experiment the soil was kept constantly moist by interrupting through drainage and creating a water-table near the surface of the soil, but the actual surface of the soil was freely exposed to evaporation through sun and

air currents during the exper.ment. This strongly injurious effect on *sal* seedlings of a constantly moist condition in loam, however, has also been obtained in another pot experiment in which good basal drainage was provided but in which the soil was kept constantly moist by merely diminishing the evaporation *from the surface.*

(*c*) Sowings in 1912-13, in sample plots in the shade of the local *sal* forests and on similar soil in the open outside the forests, respectively, resulted at the end of the first rains in 7 per cent. and 37 per cent., respectively, of healthy plants, calculated on the number of seeds sown. Similar sowings in the following year resulted in 17 per cent. and 86 per cent., respectively, of healthy plants. In these experiments the death of the large number of seedlings in the shade was preceded by more or less extensive rotting of the root. In the shade plots the surface covering of humus and organic débris was first carefully swept off so as to expose the soil below and then a seed-bed was dug and prepared for sowing in the usual way. Notwithstanding this, however, in all the experiments, the surface soil in the shade plots during the rains was invariably found to contain a higher percentage of organic matter and water and a smaller volume of water-free air-space than did the surface soil in the open, this being due chiefly to the shade of the trees which materially reduced evaporation from the soil. During the rains of 1912, the surface soil of the shade plots did not contain more than 400 c. inches of water-free air-space per c. ft. of soil, whereas the soil of the open plots contained considerably less water and more water-free air-space. It will also be seen that, in the shade plots, the water-free air-space was actually less than has been proved to be highly injurious in precisely the same

Fig. 5.

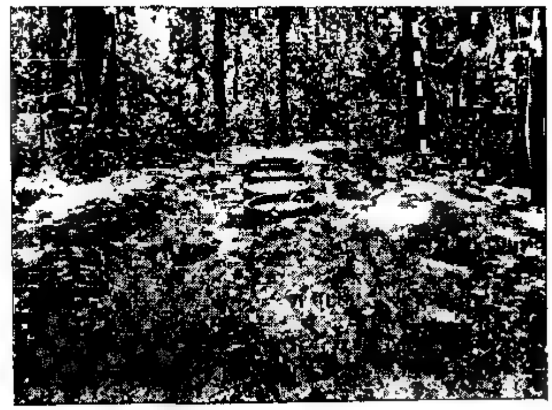

Fig. 6.

Fig. 7.

Fig. 8.

Fig. 5. Photograph of open plot III taken on July 20th, 1915, showing the appearance of the 2-years old seedlings then surviving in the plot. The distance between this plot and plot XI. (*see* Fig. 4) is only 64 yards.

Fig. 6. Photograph of shade plot VI taken on July 20th, 1915, showing the position of the beds and sand pots utilised in the experiment referred to in paragraph 3 (*d*). A number of plants had been removed from the sand pots and bed VI. (3) for examination before this photograph was taken.

Fig. 7. Photograph of shade plot V taken on July 20th, 1915, showing the 2-years-old seedlings then surviving in the plot.

Fig. 8. Photograph of open plot IV taken on July 20th, 1915, showing the 2-years-old seedlings then surviving in the plot.

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soil in the pot experiments, see (*b*) above. In the dry season following the rains of 1912, also, more seedlings died of drought during the months of least rainfall in the shade than in the open plots. This was explained by the fact that although there was practically no difference in the soil water-content of the open and shade plots, respectively, at a depth of 3—9 inches during this period, the roots in the shade had attained, by May 1913, an average length of 6 inches only as against an average length of 18 inches in the open. The plants in the open, therefore, having their roots in the deeper moister soil layers were comparatively safe from damage by drought. Fig. 4 (Plate 23) shows a typical shade plot at the close of this experiment in July 1915, two years after sowing. Notice the absence of vigorous seedlings in the seed-bed. Fig. 5 (Plate 24), on the other hand, shows one of the open plots in the same month. Note the numerous healthy plants now two years old. The distance between these two plots is only 64 yards.

(*d*) Sowings, in 1913, in large pots, filled some with clean sand alone and others with a mixture of clean sand and dead *sal* leaves which were sunk in one of the shade plots of the previous experiment resulted in a percentage of 82 healthy plants at the close of the first rains, as compared with 62 per cent. obtained in the adjacent soil from which the dead leaves and humus had been cleared for two years and 16 per cent. obtained in the same soil with which dead *sal* leaves had been mixed. The root-development in the sand was also materially better than that in the adjacent soil. Other experiments have indicated that the effect of this soil factor is progressively diminished by repeated removal of the humus, and also that removal of the humus by burning is practically as beneficial as removal by

brushing. Fig. 6 (Plate 24) shows the position of the pots and beds utilised in this experiment. 1—4 are the sand pots sunk in the soil, in bed VI (1) dead *sal* leaves were added to the surface soil, in bed VI (3) the dead *sal* leaves were removed by brushing and in bed VI (2) the leaves were removed by burning. As all the plants, in these experiments, were exposed to practically identical conditions of rainfall, light and temperature, the results show that the unsatisfactory development of seedlings in the shady forest is primarily due to a soil factor and not to deficient light, unsuitable air temperature or air-humidity, and also that the injurious effect is increased by an admixture of dead *sal* leaves with the forest soil but is innocuous in a well-drained sand even when dead *sal* leaves are mixed with it.

4. With reference to the chief object of the present work, *viz.*, the establishment of vigorous seedlings in the local forests, the experiments detailed above indicated—

(1) that an injurious soil factor was chiefly responsible for the unsatisfactory seedling development, in the loam of the local *sal* forests, by causing high mortality during the rains and subsequently a high percentage of deaths from drought owing to poor root-development ;

(2) that this soil factor could be put out of action by sufficiently good soil-aeration.

It appeared probable, therefore, that clearing the forest growth, removing the humus and exposing the soil freely to sun and air would produce the soil conditions necessary for successful growth, provided that the area cleared was sufficiently small to ensure the light side-shade necessary in N. India for protection from frost.

In 1913, therefore, two adjacent sample plots were selected in a portion of the Dehra forests where sowings in the previous year had given unsatisfactory results.

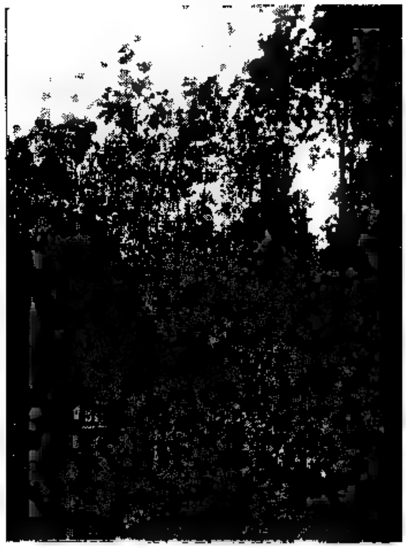

Fig. 9.

Fig. 10.

Fig. 11.

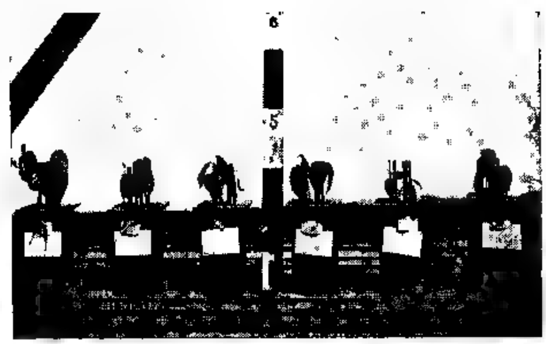

Fig. 12.

Fig. 9. Photograph of open plot IV taken on July 20th, 1915. An area 66 feet in diameter was here clear-felled in May, 1913. The figure on the right shows the edge of the clearing. The experimental plot is shown inside the fence on the left and is seen more clearly in Fig. 8. In the centre is some coppice growth from the felled trees.

Fig. 10. Photograph of open plot VIII taken on July 20th, 1915, showing the 2-years-old seedlings then surviving in the plot.

Fig. 11. The 100 feet Thano-Joli line which was cleared in 1905. The figure on the left marks the position of open plot VIII, on the western side of the line.

Fig. 12. Photograph of 12 *sal* seedlings which have been grown continuously in a water-culture solution for a period of 75 (in case of 4 plants on right) to 78 days (in case of 8 plants on left).

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Above one plot, the overhead cover was entirely removed, in May 1913, before sowing, by felling all trees above and in the immediate neighbourhood of the plot, the total cleared space having a diameter of 60 ft., or a little less than the height of the surrounding trees. In the adjacent shade plot the cover was kept intact. At the close of two years, the percentage of healthy plants in the shaded and cleared plot, respectively, was 34 and 59, the percentage of the surviving plants which had not died back was 10 and 25, while the average height of the plants was 5 inches and 12·4 inches, respectively. The fact that the ground was worked and dead leaves removed for two years in succession was responsible for the results in the shade being considerably better than usual, but there can be no question as to the marked superiority of the open plot. In the cleared plot, also, taking only the four best plants (which would be sufficient to stock the area of the plot, *viz.*, $18' \times 3'$), their average height was 21 inches, which fairly closely approaches the ideal seedling development for the locality, as obtained in the Dehra Dun garden and which was noted in para. 3 (*a*) above, *viz.*, 26 inches. Fig. 7 (Plate 24) shows the shade plot at the close of this experiment in July 1915. Note the development of the seedlings now two years old. Figs. 8 (Plate 24) and 9 (Plate 25), on the other hand, show the cleared plot at the close of this experiment in July 1915. Results almost as good as these have also been obtained on a continuous line, 2½ miles long and 100 ft. wide, running E. N. E. to W. S. W. which was cleared through the local Thano forest in 1905. Fig. 11 (Plate 25) shows the line and Fig. 10 (Plate 25) the experimental plot on the western side of the line. The photograph was taken in July 1915 when the seedlings were two years old. The four best plants then showed an average height of 18 inches.

5. The conditions necessary for the successful growth of *sal* seedlings, therefore, may be said to have been determined as follows :—

(1) a well aerated seed-bed free of raw humus ;

(2) full overhead-light ;

Fig. 13.

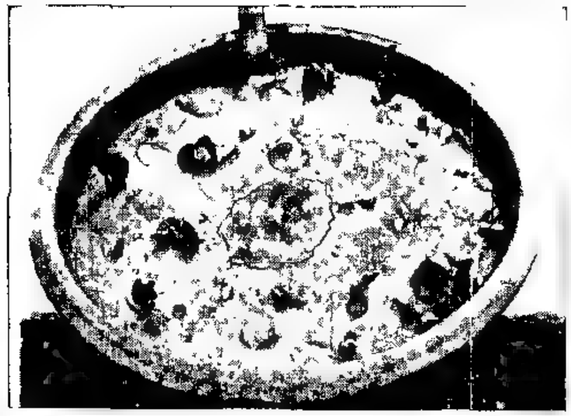

Fig. 14.

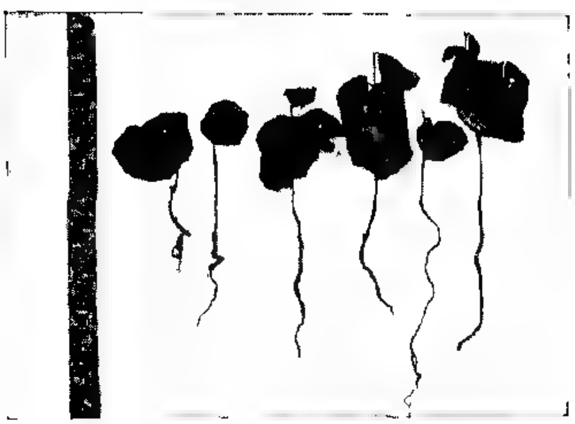

Fig. 15.

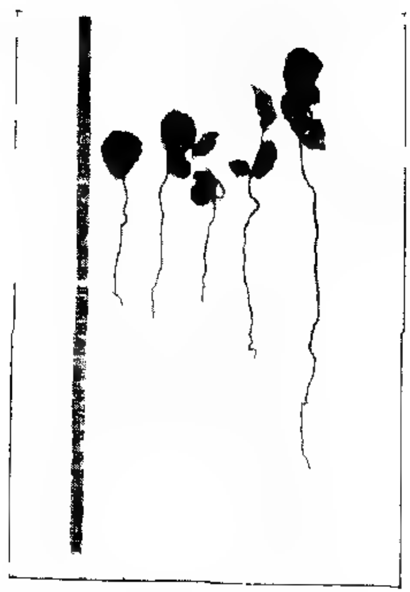

Fig. 16.

Fig. 13. Photograph showing the root-development of 6 *sal* seedlings which have been grown continuously in a water-culture solution for 78 days (in the case of the 4 plants on the left) and for 75 days, (in the case of the 2 smaller plants on the right).

Fig. 14. *Sal* seedlings growing in heavy badly aerated loam. Note the position of the surviving plants, chiefly near the porous sides of the pot where the soil is kept well aerated by evaporation from the sides.

Fig. 15. Showing the root-development of *sal* seedlings at the end of the first rains which have been grown in badly aerated loam.

Fig. 16. Showing the root-development of *sal* seedlings, the same age as those shown in Fig. 15, which have been grown in well-aerated loam.

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(3) light side-shade necessary to prevent damage from frost and which is also beneficial in keeping the soil moist in the dry season.

So far as can be seen at present, these conditions are best provided by the system of clear-felling in narrow strips and small patches, with artificial sowing and weeding during the first rains. At the same time the method which produces the best growth is not always the best sylviculturally. Thus, it is possible that the results obtained, excellent though they may be, do not yield a sufficient return to justify the high expenditure required, or the method may require more labour at a particular season than is locally available. Such considerations may render clear-felling impossible except locally in limited areas. The experiments carried out, however, indicate an alternative method of aiding the establishment of reproduction, *viz.*, by the continued removal of humus and dead leaves by light leaf-fires. In this way the number of *sal* seedlings on the ground can be materially and quickly increased Their growth is decidedly inferior to that of seedlings established in the open, but it is probable that early removal of the overhead cover may soon remedy this defect.

6. As regards the identity of the injurious soil factor alluded to, all the facts hitherto ascertained indicate that it can be rendered innocuous by sufficiently good soil-aeration and, for the present, it may be conveniently indicated by the general term bad soil-aeration. It is not at present possible to define it more exactly or to indicate the precise way in which good aeration renders it innocuous. One thing, however, is clear, *viz.*, that the injurious action is not due merely to an excess of water in the neighbourhood of the roots This has been proved by a water-culture experiment carried out at Dehra Dun during last rains, in which the injurious factor was found to be practically inoperative. In this case, after 75—78 days in the water-culture, only 8 per cent. of the *sal* seedlings died and the average length of healthy root in the surviving plants was 5·9 inches A simultaneous culture in badly aerated soil for a period of only 67 days resulted in 93 per cent. of deaths and an average length of healthy root

of 1 inch only. Fig. 12 (Plate 25) shows the appearance of the seedlings after 75—78 days in the water-culture. Fig. 13 (Plate 26) shows the root-development of six typical specimens. The infinitely superior results in the water culture clearly show that the injurious effect of bad aeration is not due to water alone. Other factors possibly concerned are the lack of sufficient oxygen for root respiration and the accumulation in injurious quantities in the soil of one or more substances which are directly poisonous to the roots and which are probably chiefly produced as a result of the decomposition of the organic matter in the soil. Further work is required to determine the relative importance of these factors.

7. The details given above indicate that the two primary factors influencing the development of *sal* seedlings are :—

(1) Bad soil-aeration which comes into operation especially in the rainy season.

(2) Drought which causes widespread damage during the season of short rainfall from September to June.

The relative importance of these factors necessarily depends to some extent on the character of the soil. Broadly speaking, three principal soil types can be distinguished in the local *sal* tracts as follows :—

(A) Containing a large percentage of sand and a relatively small percentage of finer particles of silt. The soil is also frequently shallow with gravel and boulders below and is, therefore, essentially dry.

(B) Well-aerated deep loam.

(C) Badly aerated deep loam. This differs from (B) chiefly in being denser with less pore-space per c. ft. and with a slower rate of surface percolation. Experimental cultures in these soils both in pots at Dehra Dun and *in situ* in the local forests and grasslands have shown that (A) is usually unsuitable for the best growth of *sal*, inasmuch as the water-content of the soil falls rapidly to the death-limit after the close of the rainy season, while (C) is unsuitable on account of bad soil-aeration which leads to a low percentage of

germination, a high percentage of deaths during the rains and a high percentage of deaths during the dry season on account of the superficial poorly developed root system.

On the other hand, *sal* attains its best development on soil (B). Fig. 14 (Plate 26) shows *sal* seedlings growing in soil (C) in a pot. Note the position of the surviving plants near the porous sides of the pots where the soil is kept well-aerated by evaporation from the sides thus indicating the necessity for good aeration in this soil. Fig. 15 (Plate 26) shows the root-development of seedlings grown on this soil at the end of the first rains, whereas Fig. 16 (Plate 26) shows the comparative root-development of seedlings of the same age grown on soil (B).

8. Observations have also shown that the above types of soils are locally characterised by distinct types of vegetation as follows:—

Soil (A)—Dry miscellaneous forests with such species as *Acacia Catechu, Dalbergia Sissoo* and *Bombax malabaricum* prominent, or grassland with *Saccharum Munja* dominant, see Figs. 17, 18 and 19 (Plate 27).

Soil (B)—*Sal* forest or grassland with *Saccharum Narenga* dominant, see Figs. 20 (Plate 27) and 21 (Plate 28).

Soil (C)—Moist miscellaneous forests with *Butea, Stereospermum, Terminalia, Cedrela* and others, or grassland with *Erianthus Ravennæ* dominant, see Figs. 22 and 23 (Plate 28).

In this locality, therefore, soil-aeration and the soil moisture-content appear to be the chief factors influencing the natural distribution of *sal* and the type of forest. It will also be noticed that the dominant grasses on an area may be excellent indicators of the soil conditions and therefore help us in selecting those grasslands and forest areas in which afforestation with *sal* offers the greatest chance of success. Their presence in a *sal* forest, also, indicates the treatment likely to favour reproduction. Thus, in this locality, where *Saccharum Narenga* is dominant the soil moisture and aeration are, as a rule, suitable for the best development of *sal* but in shady forests in such areas the seedlings are apt


Fig. 17.


Fig. 18.


Fig. 19.

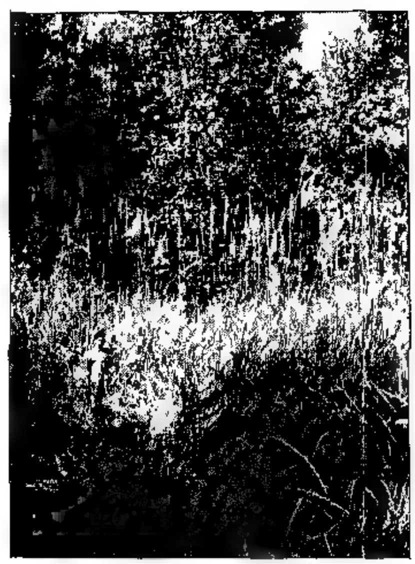
Fig. 20.

Fig. 17. A savannah of *Saccharum Munja* occupying the sandy soil on the banks of the Tons and Asan rivers, Dehra Dun.

Fig. 18. *Acacia Catechu* forest established on an island of boulders and sand in the Song river, Dehra Dun. On the edges of the forest *Saccharum Munja* and *Saccharum spontaneum* can be seen.

Fig. 19. Dry miscellaneous forest occupying deposits of boulders and sand on the banks of the Song river, Dehra Dun. The forest consists of *Bombax malabaricum*, *Odina Wodier*, *Acacia Catechu*, *Dalbergia Sissoo*, *Moringa pterygosperma* and others. On the edge of the forest are *Saccharum Munja* and *Saccharum spontaneum*.

Fig. 20. *Saccharum Narenga* the dominant grass in *sal* forest near Jhajra, Dehra Dun.

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to suffer severely from bad soil-aeration. The most efficient remedy here consists in decreasing the humus supply, coupled with partial removal of the overhead cover and exposing the soil.

On the other hand, where *Saccharum Munja* is dominant, this usually indicates a soil too dry for the best *sal* development and improvement should aim chiefly at increasing the soil-content of humus and water by continued protection and shade. On loam, where *Erianthus Ravennæ* is dominant, the main object should be to improve the texture of the soil. This will both improve the aeration and the water-supply. There appear to be two chief methods of effecting this: (1) by the introduction of an underwood as a soil-protection and thus increasing the humus supply, and (2) by cultivation of the soil. This will improve the soil-aeration by increasing the pore-space and will also increase the water-supply by facilitating the percolation of rain-water into the soil and by diminishing water-loss through evaporation. It is believed that these principles will be found to be of wide application in the *sal* forests of India generally and that practically all these forests can be placed in two main classes which may be termed Moist Sal and Dry Sal, respectively. In the former, the dominant grass is usually *Saccharum Narenga*, whereas the latter which occur both on sand and loam are characterised chiefly by such grasses as *Saccharum Munja*, *Saccharum spontaneum*, *Eragrostis cynosuroides*, *Imperata arundinacea*, *Vetiveria zizanioides*, *Andropogon contortus* and *Ischæmum angustifolium*.

9. From the above remarks it will be seen that the important characteristics of soils are, to a considerable extent, of a temporary character only, and that one of the most potent factors affecting the quality of the soil is the admixture of organic matter. This factor, also, is to a great extent within our own control. A second important factor also within our control is that of mechanical compression which affects soil-aeration adversely by reducing the pore-space. Fig. 24 (Plate 28) shows four *sal* seedlings all grown on the some soil taken from a local *sal* forest. The two central plants are one-year-old and were grown in the soil when well loosened, the others are 2-year-old plants grown in the same soil after it had been

moderately consolidated by pressure. Note the remarkable difference in root-development. This result of consolidation clearly indicates the harm that may be done by permitting grazing in *sal* forests on loam, especially during the rains.

10. It is not generally realised how greatly the characteristics of a soil may vary from place to place in a very limited area. Thus, in one of our forest experimental plots, the time in seconds required for ½ inch of water to percolate below the surface in two spots, only 9 ft. apart, was 3,000 and 423, respectively. It is believed that local variations of this kind frequently account for the fact that groups of *sal* of good growth are often seen on a soil which, as a general rule, is not suitable for the best development. On a first class soil, on the other hand, *sal* would occur practically pure, throughout, instead of as isolated trees or groups.

11. With reference to the question of plant diseases it may be noted that modern pathologists are now being forced to the conclusion that many of these diseases which were previously ascribed to fungi as the primary cause are really due to an unsuitable water-supply. Thus suitable conditions for the attack of the fungus *Valsa oxystoma* which kills out alder trees in Germany are said to be brought about by a deficient water-supply.

Again Dr. Appel, in a paper read at the 25th Anniversary of the Missouri Botanical Garden in America, in October 1914, stated that "The fungus diseases of our trees belong, in general, to the most important diseases, and we yearly lose millions on their account * * * Münch has proved through numerous experiments that the content of air in the tissues is the determining factor * * * the content of air is dependent on the quantity of water and the occurrence of this large class of plant diseases depends upon the water-supply."

From this point of view, therefore, it appears that the majority of the fungus diseases of our trees can be prevented, provided we can keep our plants in healthy vegetative activity with their tissues fully supplied with water, and that any factor interfering with the normal intake of water, such as drought or bad aeration, will therefore render our trees more liable to fungal diseases. In this

Fig. 21.

Fig. 22.

Fig. 23.

Fig. 24.

Fig 21 *Saccharum Narenga* the dominant grass in *Sal* forest near Jhajra, Dehra Dun.

Fig 22. *Erianthus Ravennae* in moist miscellaneous forest near Kansrao Dehra Dun. The trees are *Odina Wodier*, *Butea frondosa*, *Gmelina arborea*, *Terminalia tomentosa*, *Mallotus philippinensis* and others.

Fig. 23 *Erianthus Ravennae* in moist miscellaneous forest near Kansrao, Dehra Dun. The trees are *Mallotus philippinensis* and *Cordia Myxa*.

Fig 24. *Sal* seedlings grown in loam from a *sal* forest The 2 central plants are 1-year-old and were grown in the soil when well loosened. The others are 2-years-old plants grown in the same soil after it had been moderately consolidated by pressure. Note the difference in root-development

Photo. engraved & printed at the Photo.-Mech'l & Litho. Dept., Thomason College, Roorkee.

connection it is significant that the *sal* root fungus recently discovered appears to be most injurious in the wet *sal* forests of Assam and the Bengal Duars where the absence of reproduction is known to be due chiefly to bad soil-aeration. The *sisoo* root fungus, also, is most injurious in *irrigated* plantations. Again the symptoms of Spike Disease of *sandal* strongly resemble those of a plant suffering from an excess of CO_2. The latter gas is known to accumulate in soils under conditions of poor aeration, and it is possible that deficient soil-aeration is the factor which, in some cases at least, is responsible for the disease. In other cases it seems probable that a deficient water-supply, due to the absence of suitable hosts or drought, is the primary factor and this has already been suggested by local officers who have had an opportunity of studying the disease in the field. There is thus reason to believe that the continued study of the requirements of our *important species in respect of soil-aeration* and water-supply will give us valuable results in connection with the prevention of diseases.

That the view here taken regarding plant diseases has now been adopted to a considerable extent in India will be seen from the following extracts from the latest Annual Report of the Board of Scientific Advice for India.

The officiating Imperial Mycologist at Pusa, discussing the *sal* root-fungus from the point of view of the expert Mycologist, says : "The fungus has been obtained in pure culture and will be tested by inoculations. While it is not unlikely that the fungus is the direct source of damage, it will probably be found that the conditions under which the *sal* trees are living are such as favour the presence of a fungus parasite and decrease the vitality of the *sal* tree. When the factors which are necessary for the fungus to gain an entrance into a healthy *sal* tree are known it may be possible to control the disease by altering the hygienic conditions under which the trees live and thus lessening the chances of a successful infection."

Again Mr. Howard, the Imperial Economic Botanist of Pusa, referring, in the same report, to the Dehra Dun work on *sal*

seedlings, says: "In the development of *sal* seedlings in the forest and also in the case of many agricultural crops in India, want of sufficient air for the soil organisms and roots has been found to be a limiting factor in growth. The proper aeration of the soil is chiefly interfered with by excess of moisture either in the form of rain or as irrigation water. Unless the proper relations between air and water are maintained, it is found that growth slows down and finally a diseased condition results. Water, when it excludes air from the roots, soon acts as if it were a poison to plants. As soon as gaseous interchange between the soil and the air is interfered with, there is considerable evidence that the proportion of oxygen in the soil atmosphere falls while, at the same time, the carbon dioxide rapidly rises. If this condition continues, a slow poisoning of the plant begins and, after the cessation of growth takes place, the foliage becomes yellow and unhealthy. The next stage is that of well-marked disease, often accompanied by invasion of the tissues by insects and fungi which are not unnaturally regarded as the causes of the trouble. * * * * There seems no doubt that the rôle of insects and fungi in the diseases of crops has been somewhat exaggerated and that a truer point of view is to regard these so-called pests as indications that the well-being of the crop is being interfered with by causes such as unfavourable conditions of growth, due to the soil or to the climate."

In conclusion, it must be noted that the results which have been mentioned in this paper are very largely due to the hearty co-operation of Mr. Puran Singh, our Chemical Adviser, who has carried out all the analyses of soils and water determinations.

SOME PHASES OF FOREST ADMINISTRATION IN CALIFORNIA.

BY THEODORE S. WOOLSEY, JR.

In a former article on "The American Forest Service," published in the *Indian Forester* (June and July 1909), the writer gave a brief account of the organization of the Forest Service, of the amount of business it was transacting, and some of the technical phases of the work, such as timber sales, marking and sylviculture. Since that article was published, the organization has not been materially altered. There have been some changes, however: the district organization has been simplified. A new district, District 7, has been founded, which manages the lands purchased under the Weeks Law, new forests are being organized in Tennessee, Georgia, Virginia, North Carolina, West Virginia, and New Hampshire. This new district, which has its headquarters in Washington, also includes the Arkansas, Florida, and Porto Rico (not organized) forests, formerly administered by District 3 at Albuquerque, New Mexico.

In the Central Bureau in Washington, there have also been some changes. A new branch, entitled "Research," has been established. The Forest Service is now directed, as in 1909, from Washington. It is headed by a "Forester." There are seven districts each in charge of a district forester, and 153 forest administrative units each under a forest supervisor. The Central Bureau is divided into accounts, operation, sylviculture, grazing, lands and research. The editorial and special hydro-electric engineering work and dendrological studies are directly under the forester and not in any particular branch. The district forester is advised by a solicitor working under the solicitor of the Department of Agriculture, and the various district offices are: Accounts, Operation, Sylviculture, Grazing, and Lands. The forests are divided into ranger districts, but often important projects such as large timber sales are under the charge of specialists without relation to the ranger in charge of the district, but instead directly under the forest supervisor. Since 1909, eight experiment stations have been established, and the importance of research work has

increased tremendously since the early organization. Most of the stations undertake experiments of general value, the results of which will apply directly to future administration. There are some exceptions: the Converse Experiment Station on the Angeles National Forest in Southern California specialises in planting. The Wagon Wheel Gap Experiment Station on the Rio Grande National Forest in Colorado is run in co-operation with the Weather Bureau in order to determine scientifically the effect of forest cover on run-off and the related problems. The final results will be authoritative and of world interest.

According to the October 14th report of the Forester for the fiscal year ending June 30th, 1915, a net area of over a million acres of land was eliminated from national forests during the last fiscal year by acts of Congress. The net area as of June 30th, 1915, excluding private interior holdings, was 162,773,280 acres. During the same period, the cash* receipts were $2,481,469·35, of which 1·17 million was derived from timber, 1·14 million from grazing fees, and ·17 million from special uses and rentals. While this was an increase of less than $50,000 over the year before, the small increase is clearly accounted for by the depressed lumber market due in part to the European War. These returns do not include almost a quarter of a million of free use material which was donated to settlers. The receipts were less than half the appropriation required for carrying on the Forest Service. In other words, no revenue is derived, but, instead, the Service nets the Government a loss of over three million dollars. The main reason for this large deficit is because the forests were organized not alone to take care of the revenue-producing business, but also to protect vast bodies of valuable timber which cannot as yet be placed on the market.

Reforestation by direct sowing was continued and a total of 5,876 acres were sown, the area planted was 9,731 acres, and, according to the Forester's report, "The area planted annually will be kept normally at 14 or 15 thousand acres." The average cost was ten dollars per acre for plantations and $4·39 per acre for direct sowing.

* One dollar = about Rs. 3

It is undoubtedly of interest to Indian foresters to learn that 25,641 permits were issued for stock grazing and that 1,627,321 cattle, 96,933 horses, 2,792 hogs, 7,232,276 sheep, and only 51 409 goats were grazed. Only $400,000 was available for the "construction and maintenance of improvements." Consequently, the maintenance of 108 miles of road, 1,719 miles of trails, 2,287 miles of telephone lines, 166 miles of fire-lines, 102 look-out structures, 35 bridges, 267 miles of fence, and 696 dwellings, etc., 23 corrals and 202 water improvements is an excellent record. Naturally part of this work was accomplished by employees on the statutory roll. According to Act of Congress, ten per cent. of the gross receipts is available for local road-building under the direction of the Forest Service. This supplements the twenty-five per cent. of the gross receipts which "is paid over to the States by the federal government for the benefit of county schools and roads." Since the forests cannot be taxed locally, this payment is really in lieu of taxation, and when the forest revenue is largely increased, as it will be, it will mean a handsome sum for the civil governments. The road and trail money expended under the direction of the Forest Service was nearly a quarter of a million, and the school and road money spent by the counties more than half a million. Besides the Forest Service in Washington, there are, in addition, 34 State "Forest services" and these are aided by federal appropriation for fire-protection as soon as the State qualifies by passing a suitable forest fire law.

Notwithstanding the fact that each district works under practically uniform laws and instructions, there is some variation in the methods of work due in part to different local conditions and in part to the variation of ideas between the district foresters. I will allude, however, to but one of these variations. This variation is one in organization and is illustrated by the following table:—

District.	Number of administrative units.	Gross area of district (million acres).	Average area of administrative unit (thousand acres).
1	26	27	1,036
2	32	23	716
3	16	21·5	1,345
4	34	30	875
5	19	26	1,376
6	26	27	1,951
7	(Not considered)		
Total .	153 Average area per district.	25·75	

A check of this table shows that the average number of units per district is 25 ; the minimum of 16 for District 3 and the maximum of 34 for District 4. The average unit is slightly over one million acres, but varies from 715,740 acres per administrative unit in District 2 to a maximum of 1,376,208 acres in District 6, with District 3 a close third to the maximum with 1,345,978. Surely such a tremendous difference in the average acreage between administrative units in Districts 3 and 2 must signify a fundamental difference in organization followed by the two district foresters. This is all the more significant when it is realised that District 3 is planning a further increase in the size of its administrative units by reducing the number of supervisors from 16 to 8. This, however, has not as yet received the sanction of the Central Bureau although recommended by the district forester. The reason for this difference is an interesting one. In District 2 the district office evidently believes in a personal administration by each supervisor. In District 3, the district forester feels that a supervisor on a first class unit should be assisted by a staff of grazing, timber sale, lands, and engineering specialists. In other words, he argues that, notwithstanding the duplication of travel, that it is better to have the supervisor and his alternate (the deputy forest supervisor) leave to specialists the work of specialists. This is a question which has

not, as yet, been decided, but the problem is of keen interest to every professional forester. My own idea is (at least in theory) that with a local staff organization, which must naturally follow if the supervisor has 3 or 4 million acres to administer, there is no need for the present district organization, that it would be better to have the administration wholly centralised in Washington with one or more general inspectors for each district to supplement specialist's inspection from the Central Bureau. This is a problem which merits close scrutiny on account of the enormous expense of the present districts.

From this brief allusion to the organization and business of the present Forest Service, it will be seen that the business does not really justify the present organization unless the deficit is charged to the protection and recreation value of the forests. I feel that the money is well spent, but that it would probably advance the business efficiency of the organization if all research and co-operation were placed in a separate bureau, and the business of organizing and administering the national forests separated and financed as a distinct project.

It has been seen that California in its entirety comprises one of the six districts locally known as District 5. California has commercial forests and non commercial forests, those in Southern California comprising the Santa Barbara, Angeles and Cleveland are non-commercial forests. According to Smock*—

"Southern California may be divided into three fairly well-defined topographical divisions: The intra mountain or Mojave Desert region in large part; the mountain consisting of the Sierra-Madre and San Bernadino and San Jacinto ranges, and the coastal plain, that part of the State lying south and south-west of these ranges and stretching westward to the ocean."

The national forests occupy the second or mountain division and, unfortunately, contain but little merchantable timber. A large part of these forests is brush land, so-called "Chaparall." The more important species in the timber types are western yellow

* "An afforestation scheme for Southern California," John C. Smock, No. 4, Vol 9, Proceedings of Society of American Foresters.

pine, white fir, and Douglas fir. The brush is chiefly manzanita (of the arctostaphylos genus), snow bush and white thorn. This Chaparall cover is of value in preventing erosion and in retaining soil moisture, but has no commercial value worth mentioning. Smock in his article calls attention, however, to the large areas of land outside national forests in Southern California which should be afforested to ameliorate the climate by reducing somewhat the wide daily range of temperature and by increasing air-moisture and to prevent frosts. The tremendous value of the coastal plain region*—the agricultural area—comprising, in Southern California, about 3,000 square miles, is well known. It is probably the most valuable agricultural land in the United States and, consequently, the 3,500 square miles not suited to agriculture, practically unproductive of any revenue to the State leads the forester to consider forestation notwithstanding the difficulty and expense. In concluding his article Smock says :—

"This afforestation on the large scale, as suggested in this paper, as a means of making the streamflow of these wild lands of value, of increasing the rainfall to a slight extent, and of reducing the losses of heat and moisture through evaporation, and thereby producing a slight amelioration of the climate, would in time yield a return in forest products which might in time be of sufficient value to pay in part the invested capital. Timber values can be computed with reasonably accurate estimates, even on so large a scale. If the investment were lacking in commensurate profit, the additional water-supply for local use in the surrounding valleys would be a perennial source of wealth to the country. The enrichment in natural beauty and the attractiveness would constitute elements of public wealth in justification of so large a scheme of afforestation."

The only objection to foresting these low-lying hills is the large increase in real estate values and the extension of suburban residences 20 to 30 miles from the municipal centre of Los Angeles Enthusiasts predict that some day even the low-lying hills around

* It is similar to some of the best coast land in Australia as contrasted with the interior "bush."

the coastal plain will be required for residences, but the forester will argue that this is all the more reason for afforestation to increase and preserve an already scanty water-supply and to enhance the local beauty.

The importance of the Angeles Forest (formerly known as the San Gabriel and San Bernadino Forests) comprising 1,159,663 acres gross area, of which 271,629 acres is alienated, is two-fold: first, as a watershed and drainage area, second as a camping and recreation ground for a local population of over a million people. With the present wide ownership of motor cars, the Angeles Forest is even more accessible to the public than even such play-grounds as the Wienerwald near Vienna or Fontainbleau near Paris. I am reliably informed by the supervisor of this forest (R. H. Charlton) that, on July 3rd, 4th and 5th, 1915, no less than 1,800 people picnicked in the Arroyo Seco above the town of Pasadina to the north-east of the City of Los Angeles. Charlton estimates that "350,000 people so use the forest annually."

The flood of 1914 aroused the supervisors of Los Angeles County to the necessity of immediately taking steps to prevent the recurrence of damage conservatively estimated at a direct physical loss of $7,600 000 by the Provisional Report of the Board of Engineers, June 3rd, 1915. It is significant that* "All the waters that bring about the destructive floods rise in National Forest Reserves which occupy 1,520 square miles of the total 4,967 square miles of Los Angeles County." According to the preliminary report :—

"The methods available for flood control are broadly separable into two general classes opposite in their action. First, those which accelerate the discharge of the main streams, such as improvements and straightening of channels. Second, those which retard and regulate the flow of feeders into the main streams, such as dams, the spreading of waters, the planting and preservation of trees and especially of low growing bush and willows."

* Page 3 of Provisional Report of Board of Engineers, June 3rd, 1914, p. 22.

It was estimated that disastrous floods occur at least once in eight years and that there were "Heavy floods in the Los Angeles River in 1825, 1833, 1862, 1867, 1886, 1889 * * * and serious floods in 1892, 1906, 1911 and * * * 1914." * The rapidly increasing value of the land to be protected is a factor to be considered.

The improvements on the Angeles Forest for the year ending June 30th, 1915, were: Trails, 53·4 miles; telephone lines, 17 miles; fire-breaks, 6·1 miles; 1 look-out tower; 1 house; 1 barn; 1 small building; 1·05 miles of fence. Since the forest was organized it is interesting to note that $146,265 has been spent on improvements, the most important items being: Trails, $94,036, fire-breaks, $22,669, dwellings, $11,462. The most remarkable spirit of co-operation exists. In 1914, 44 private owners, corporations, municipalities contributed $20,078 towards patrolling, trails, fire-breaks, telephone lines and look-out houses. On no other forest in the country is there the same co-operation; *this in itself is a formal public recognition of the indirect value of forest protection.* For example, the San Antonio Fruit Exchange contributed $1,499 to protect the San Antonio Canyon; this money is raised by taxing each box of citrous fruit at a quarter of a cent. No less than 333 special use permits were issued, making a total in force of 957; this is evidence of the wide use of the forest by the public. While such wide use is of revenue importance, it also means an added fire menace.† No less than 581 of the permits in force were for residences. Other permits issued were for agriculture, apiaries, camps, dance halls, fish hatcheries, parks, pastures, photo studios, resorts, road houses, schools, stores, garages, telephone lines, trollies and water development. Permits were also issued for the grazing of 3,054 horses and cattle; no sheep or goats were grazed. No timber sales were made for amounts over $100 and but 581,000 ft. B. M. were cut during the fiscal year. The planting covered by 64

* Disastrous floods occurred again in January 1916, just as the article is being mailed.

† See next note by Charlton.

acres and the sowing 2·8 acres; infinitely poor results owing to drought and frost. The practical abandonment of planting or sowing other than on an experimental scale is an acknowledgment of the difficulties encountered.

In 1906, the expenses were $30,910, the receipts $1,819, giving a deficit of $29,091. This was for the first fiscal year that the Forest Service took charge. In 1913, the expenses were $57,458 and the receipts $15,814, giving an increased deficit of $41,643, notwithstanding the large increase in receipts because of the expensive organization which is maintained largely on account of fire-protection. In 1914, the expenses had increased to $62,504 and the receipts to $28,286; the deficit was $34,318. This is a cost per acre of ·05363 and the receipts ·02427. During the past fiscal year (1915) the net receipts were but $15,005. Of this $1,276 came from the sale of timber, $32 from timber trespass, $1,502 from grazing, $9,774 from special uses, and $2,421 from water-power. These receipts, much lower than those of 1914, are less because of the small payments for use in hydro-electric power. Ordinarily the receipts from now on will be well over $30,000 and probably soon will reach the $40,000 mark. It is noteworthy that Mr. Charlton, the present supervisor, has increased the revenue from $1,819 in 1906, when he took charge, to a maximum of over $28,000 in 1914. Such an administration is unquestionably quite remarkable and he confidently predicts further increases in revenue. The deficit in receipts is emphasized because I want to show that the United States is progressive enough to spend a great deal of money on forests that are practically worthless commercially, in order to protect valuable water resources and in order to furnish a play-ground for the people.

The important work on this forest is, first, fire-protection, and second, construction work in connection with fire-protection, and in order to give access to the forest for campers, third, location and control of summer residents* and transient campers. These will be discussed in the order given.

* Charlton states that:

"The summer resident is not necessarily an added menace. For instance, we require him to clear his lot of all inflammable débris, and having a financial interest in the canyon, he really becomes a member of our protection force. . . . ."

In the words of the district forester :—

"Fire-protection is not only a public service of vital importance, but it has become a game to us, a game which we play with increasing enjoyment. Evidently the district forester has in mind a game similar to that of the game of war; a game to be sure, but withal an exceedingly serious one. The causes of fire within the Angeles Forest in the order of importance are: campers and hunters, railroads, brush burning, and of less importance, lumbering, lightning, incendiary, miscellaneous and unknown causes. Naturally, the first aim of the force is to prevent fires. With fire once started in the brush (which is very much like the 'maquis' of Corsica), it is very difficult to put it out, since these fires usually start in the bottoms of canyons or at the foot of slopes and can rarely, if ever, be controlled until they have reached the summit, notwithstanding the fire-lines which have been constructed. The preventive firework naturally aims at the most important causes. With the wide use of the forest, it has been found necessary to issue so-called 'camp-fire cards,' authorising the building of camp-fires on National Forest lands. While these permits could probably not be legally enforced without a secretary's regulation or a local State law yet they have been accepted by the camping public without exception. The permit authorises the bearer to build camp-fires between certain dates, subject to the following requirements :—

"(1) To build camp-fires only.

(2) To build fires in the open and not against a tree or log nor within 20 ft. of standing brush.

(3) To scrape away all leaves and brush from around fire.

(4) To never leave a fire unattended even for a short time without first extinguishing it.

(5) To extinguish fires first with water and then to cover with dirt. Bonfires are not allowed on the Angeles National Forest."

On the reverse of the cards, campers are informed what to do in case they find a fire; first, try to put it out, then get word to the nearest ranger. The supervisor's telephone

number is given as an additional precaution. They are also cautioned to leave their camping grounds in a sanitary condition, not to pollute streams, not to throw away lighted matches, cigars or cigarettes, and finally —

"The Angeles National Forest is maintained by the Government for your benefit. Please co-operate and prevent fires."

The rangers have even built rock fire-places for picnickers to lessen this particular danger, special camping grounds are also reserved. Of course, the usual fire-warning posters are along all roads and trails and, in addition, there are special notices to campers as for example, "Camp-fire cards must be obtained from the ranger before fires can be built on national forest land." The regular fire warnings are printed both in English and Spanish and, in addition, there are frequent placards giving the addresses of the fire-prevention force, rules for the prevention of fire and warnings about prosecutions which will follow violations of the law. To prevent fire from railroads, fire lines parallel with the track are constructed and kept clear; these commence at the right of way and extend a distance of 100 ft. from the track. To prevent fires from indiscriminate brush burning notice must be first given by those wishing to dispose of débris, and inside and outside the forest fire officials either from the Federal or State service are usually present.

The situation of the Angeles Forest, bordering areas of agricultural land makes the prompt detection of fire fairly easy, since the whole country is connected with an efficient telephone service. On most national forests, the key to the fire preventive scheme is a series of fire look-outs connected by telephone with the district fire chief, who, in turn, is connected with the supervisor's office. On the Angeles, thus far, but one fire look-out has been established. Charlton believes in prevention rather than in detection.

"We realise that a fire once started in the brush is very difficult to control, and for that reason do all in our power to educate the city people who frequent these hills on the danger of leaving fires."

A good deal of difficulty has been experienced with look-out stations on account of the haze which obstructs the view. The chief preventive measure is, therefore, patrol, which of course is exceedingly expensive; probably more look-outs may be used in the future, but patrol will always be very necessary on account of campers. The preventive organization attends fires only on its own district. There are three division rangers at Pasadina, San Bernadino and Upland, where the supply depôts are located. Supply depôt chiefs, in case of fire, see to it that crews of men and "straw bosses" are sent out by motor truck and that the proper tools and food are despatched immediately. Of course, the location of each fire district is clearly established on the map and the fire tools, supplies and fire-fighters are all arranged for in advance.

Even the field officers have very detailed directions, instructing them to "phone the division ranger how many men to be sent, how to be sent, what tools to send, rations, what work, outfits and bedding, and to make sure that there is no duplication of orders." The district forester is very keen for a large fire supervisory force and a detailed organization when once fire is discovered.

Suppose that a fire has started. According to the organization chart, the division ranger, or, if it is an important fire, the supervisor would be in direct charge. Under him, there would be a chief of fire fighting with a division leader and crew leaders (straw bosses), in charge of from ten to twenty fire-fighters. There would be a quarter-master, with a commissary chief superintending the cooking, and a transportation chief to see to the motor transportation, team hire, pack outfits and saddle horses, an equipment chief to look after tools and special equipment, a powder man to supervise blasting, a communication chief to supervise telephone, heliograph messages, and messengers, a time-keeper with the necessary assistants, and a paymaster. At the fire which I attended on this forest, the organization was not quite so complicated, the following procedure being followed: The fire was in Lydle Creek, some 15 miles out of San Bernadino. The division ranger remained in San Bernadino and saw to the shipment of men and supplies, as well as proper publicity, while the fire was

raging. The supervisor had general charge at the base camp and directed the fire campaign after consulting with the various local rangers. Each crew of ten to twelve men was in charge of a boss, and messengers were employed to send water, food, and give directions to the crews. A commissary chief checked over the supplies and gave them to the cooks. The chief clerk of the supervisor's office acted as time-keeper, assisted by an office stenographer. The feature of the time-keeping was a serially numbered card with places for the date and the time for going on-shift and off-shift, with a summary of the number of hours worked during the day from midnight to midnight. At the bottom of the slip, the rate per hour for fire-fighting (in the United States,* the standard rate is twenty-five cents; Charlton pays "bosses" forty cents), with an additional space for recording the number of hours spent in coming to and from the place where the labourer was engaged. At the beginning of the fire, each labourer (whose name and address was inscribed at the head of the time slip) was given a numbered slip which identified him definitely by number. Time was kept by numbers only.

Most of the men seemed familiar with their duties on account of past experience in fire-fighting. The food-supply distribution was systematised. For example, when making up lunches for the men, bread was buttered by painting melted butter on the bread with a paint brush. The usual lunch was cheese, sardines, bread and butter, and jelly. In camp, the men received beef, potatoes and coffee. Special fire-irons had been brought from town for the cooks and board-tables were arranged in a semicircle, much as you find in railroad lunch counters. Quilts were provided for the men to sleep in when off duty. The lighting equipment was kerosene lanterns and acetylene pocket lights, which, by the way, failed to act properly, axes, shovels, and grub hooks. When a fire is once controlled, great care is taken to patrol the burned areas to prevent a re-kindling of the fire-lines; men even creep along these lines and feel the burned ground with their hands to make sure that nothing inflammable remains.

* One rupee = about 32 cents.

In some of the very large fires which have devastated California forests, the danger point in the organization has always been reached when one man tried to do it all himself. It is for this reason that the district forester is strongly in favour of spending a little more money on this apparently top-heavy fire-fighting organization. On March 20th, 1914, 1,600 acres were burned over in Evey Canyon. The fire was caused by the transmission wires of the Sierra Power Company blowing down in San Antonio Canyon. The wind was so strong at the time that houses were unroofed in Pasadina and ashes from the fire were carried to Glendora, twelve miles away. The fire started first at 9-30 A.M., and was controlled the first night. The S. P. L. A. and S. L. fire, November 19th, 1914, in Cajon Pass, was started by the railroad, 110 ft. from the outer rail. 1,203 acres were burned over, and the cost of putting it out was $1,450. These two examples of recent large fires show what would happen to the forest without the expenditures on fire-protection.

To simplify the collection of fire-trespass money, the local officers have based the damages on the artificial cost of replacement when young growth is wiped out. For example, if the growth is ten years old and two feet high, its value is estimated at $16·30 per acre. If sixty years old, and eight inches in diameter, the damages are assessed at $73·14 per acre. In addition, they add the sale value of the wood destroyed. The figures just quoted are based on a replacement cost of $12·00, a protection cost of ·015 per acre every year, interest at three per cent. compounded annually, and 1,200 trees per acre.

On account of the vast amount of improvement work on the Angeles Forest, special cards are maintained to show the cost of construction (with additions) and the maintenance cost of each project. The cards show the name of the project, who supervised construction when it was constructed, whether it was built by the Government or by local subscription, location, name of terminals, length on specific dates, dimensions (if a house), losses, abandonment, or transfers, whether the project was administrative, protective or range. A detailed description of the project is given in a

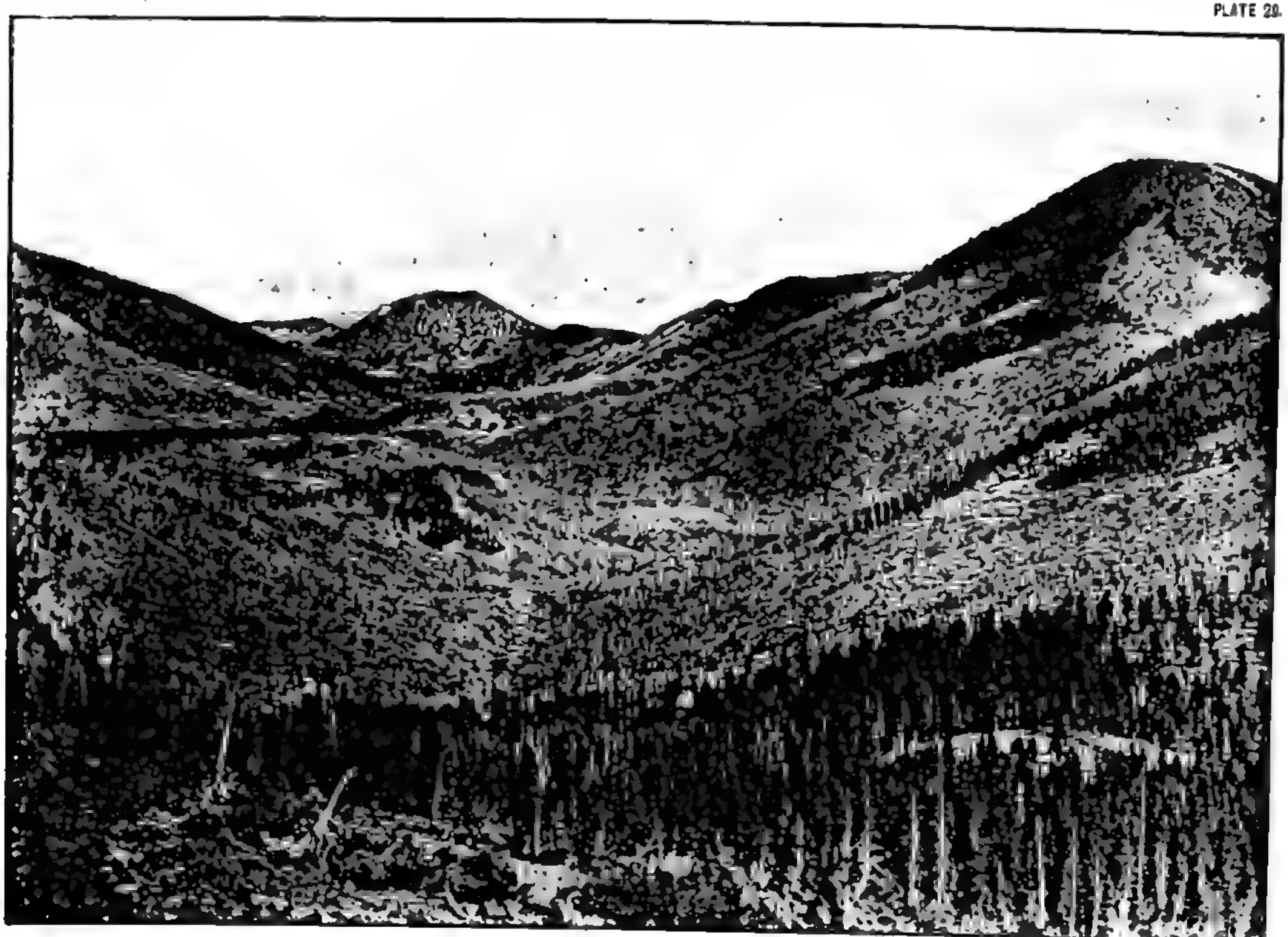

Photo-engraved & printed at the Photo.-Mechl. & Litho. Dept., Thomason College, Roorkee.

Damage from fire on the north east slope of the San Francisco Peaks, Coconino National Forest, Arizona.
This fire took place prior to protection under National Forest administration

summary. The road work is laid out by road engineers, and, thus far, the trails have usually been located by rangers or by the supervisor himself. The fire-lines are usually laid out under the personal direction of the district ranger or the supervisor, and the scheme thus far parallels the foot-hill areas below the forest, but not necessarily along the boundary. These lines are usually sixteen to sixty-six ft. wide, most of them being narrow rather than wide, since they are designed to give vantage points to fight fires from or to give access through the bush to fire-fighting points rather than to stop the fire of themselves. More fire-fighting lines have been built on the Angeles Forest than on any other forest in the United States (up to January 1st, 1916, 133 miles) and the supervisor has developed the theory and practice of fire-line construction to a suitable degree. Commenting on the width and method of construction and periodical clearing, Mr. Charlton says —

"The first fire-breaks constructed averaged 50 ft. in width, were grubbed of all roots, and were constructed with the idea that under normal conditions they themselves would check a brush fire. This they did, provided the fire reached them when there was little wind, as at night but, unfortunately, the time element could not be controlled and the breaks could not always be depended upon. We are now building narrow lines, averaging 12 ft. in width and grubbing the roots, but making no effort to clear them of the weeds and grass that annually grow upon them. By making them the same width as the height of the contiguous brush we reduce like conditions to a minimum and thereby secure a minimum growth of vegetation upon them. These breaks are designed, first, to render the ridges accessible to fire-fighters (the Chaparall is almost impenetrable) and, secondly, to afford a place from which a back fire can be set. The breaks invariably follow the main divide of each watershed, with laterals running to the bottom of the canyon. The Forest Service is now purchasing a flock of sheep to be grazed upon the fire breaks throughout the year. Heretofore the cost of maintaining a fifty-foot break by hand (hoeing the weeds and grass) has been $100 per mile. With

sheep it should not cost more than $10, and if the profits of the business are considered, should be even less."

The third great industry on the Angeles Forest is the special use business; chiefly the rental of camp sites to local residents (who occupy them during the summer months) and a conservation charge for hydro-electric power. Practically every canyon on the forest, that is now accessible and where water can be found, is occupied by permanent campers. Little house lots are surveyed in advance by the Forest Service and the corners marked. Thus the renting is systematised and conducted in very much the same manner as a real estate company rents private property. But priority of application, rather than ability to pay a high monthly rental, is the governing criterion. *The rental for a small camp site* is usually about $15 a year.

As time goes on, the revenue from the rental of sites will become increasingly large, especially when new automobile roads are developed. One of the scenic drives of the United States is from San Bernadino up to Skyline, to Big Bear Lake and back to San Bernadino, a distance of 101 miles. All along this road, where there is water, temporary and permanent camps are found between the hotels and lodges.

The forester is acquainted with the revenue-producing forest, the sale of timber and grazing, but it seems to me that the Southern California forests of which the Angeles is the best developed are noteworthy in illustrating the indirect value of forest protection. Here, we will have, in years to come, water protection and recreation developed to a maximum.

Professionally, some changes in the present order of administration are desirable. For example, the Cleveland Forest should be combined with the Angeles, with a central administration at Los Angeles. If this combination were made, it is quite likely that the supervisor would require a fire expert, who would also be an engineer to superintend improvement work, and, if the renting business increases, perhaps a lands expert to locate and designate even more permanently than is done at present,* the various rental

* On January 24th the supervisor reports that three field parties are staking, numbering, mapping, and surveying residence sites.

sites, and to assist the supervisor in formulating rules and policies governing this form of business. On account of the cement boulevards radiating from Los Angeles, even as far as San Diego (the southern limit of the present Cleveland Forest), it seems to me that it would be wise for the supervisor to maintain an automobile. Under the present arrangement, he could do so and receive an official mileage allowance which probably pays half the net cost per mile. Where the supervisor cannot afford this, as in the present case, it seems logical for the government to supply a motor car or cheap motor cycle for speedy transportation ; or better still pay a fair mileage. Personally, I see no reason why the government should expect its officials to bear part of the cost of field transportation as might be supposed judging from the present niggardly allowance. As far as fire-protection is concerned, a good sturdy motor truck (geared so that it could be run up to thirty miles on the boulevards and with a very low gear for hill-climbing), would be a wise business economy. As regards fire-lines, which are the all-important work, the main problem is keeping them clear of débris. Considering their purpose, I should like to see the experiment tried of having one-third the width cleared each year rather than the whole width cleared every three years. This is a scheme advocated in Algeria by one of the local officers in order to have part of the line absolutely clear of grass and débris every fire season.

The development of the Angeles Forest by Supervisor Charlton is a distinct contribution to American forestry and should be so recognised, the progress of the next ten years should be phenomenal. Let us hope that the experimental afforestation will indicate that extensive planting is feasible in Southern California.

EFFECT OF DROUGHT ON THE SAL IN THE RAMNAGAR FOREST DIVISION.

BY E. R. STEVENS, I.F.S.

It is a curious fact that at the time of writing this note (the 29th May) the greater proportion of Sal saplings and poles up to about 3 feet in girth in the Ramnagar Division are still leafless or comparatively so.

The larger Sal trees, on the other hand, have had their full leaf-canopy since before the end of March, the leaves having in their case begun to arrive noticeably early as a result of warm weather setting in somewhat prematurely this year.

The foliage of the larger trees is, however, in many cases feeling the effect of the long drought and is becoming very yellow and in some cases the new leaves are withering and beginning to fall.

The larger the trees, the less have they been affected.

The obvious inference is that early in the season the water-level had been reduced to such an extent as to throttle the rise of sap and check the leaf production of the younger trees while the more developed and deeply reaching root-systems and tap-roots of the older trees rendered these latter at that time immune.

Continued drought and lowering of the water-level is now however telling on the larger trees. If the drought persists much longer or even if there is insufficiency of rain during the next month it is difficult to foretell whether the hastiness of the more mature trees to don their spring garments may not prove more prejudicial to them than the absence of raiment and check in growth to the younger trees during the last few months. There must be lowered vitality in both cases and I think a bigger death-rate than usual may be expected among the Sal of all age-classes in this Division.

It would be interesting to know if similar conditions prevail in other divisions in the provinces.

TREATMENT OF BAMBOO FLOWERED AREAS IN ANGUL

(Extracted from an Inspection Note of the Angul Forest Division, dated 15th February 1916

BY H. H. HAINES, CONSERVATOR OF FORESTS, BIHAR AND ORISSA.)

The *Bambusa arundinacea* flowered over large areas two years ago and there are still standing large clumps of dry bamboos under which the young crop is coming up thickly. West of the Chotkoi village it has not flowered.

This bamboo is of very little value and, on the other hand, it occupies some of the otherwise best Sal-growing areas. It seems to me that steps should have been taken to take advantage of the flowering in order to assist the tree crop and possibly this is not yet too late. There are many deformed Sal which the sudden accession of light has caused to throw up strong shoots but many of these get twisted and broken off at the junction with the old wood and others are bent by the falling bamboos and, unless assisted, will always be useless. I recommend that some of these flowered compartments, where timber is not being extracted, should be fired at once and a drastic cutting-back be undertaken at the same time. In the rains some of the more favourable localities should also be sown or planted. The rhizomes of the young bamboo are already too strong to be killed by the fire and will send up new shoots. These should be kept under by cutting whenever cutting-back is done until the tree growth gets a decided lead. The operations will need money, but savings are being made on the stoppage of building works and some will be made on the temporary withdrawal of these blocks from fire protection, and this is a case where, if money is not spent now, the opportunity will be lost. Mr. Ribbentrop, Inspector-General of Forests, in his unofficial note, dated 27th February 1893, considers that the firing of the dead bamboo would cause "an incalculable amount of damage whereas, after five or six years' successful protection, the forest will become more or less self-protecting." I agree that the forest would be more or less self-protecting, but the resultant crop would,

EXTRACTS.

COMMERCIAL FORESTRY.

We are glad to see the Forest Economist return to the discussion of the commercial side of forest work in India, in the March number of the *Indian Forester*, our regret being that he has not gone at greater length into a subject he is so fitted to throw light upon. The Department can scarcely be blamed for having developed so little of this side of its work in the past, considering it has had to create a scientific forest system out of a

legacy of chaos bequeathed to it 60 years ago. The work of technical organisation is, however, now fairly complete, and there will not be the same excuse in the future if a sound commercial organisation is not now taken in hand. It is inconceivable that a property of this extent in the hands of a commercial company *would not by now be yielding enormous profits; but this would* have resulted from a totally different policy in its administration. Hand in hand with its scientific conservation and development would have gone a bold policy of outlay; capital would have been put into the property in the form of roads tramways, ropeways, timber marts and saw-mills, and a host of trained agents would have been on hand to keep producer and purchaser in touch. But there is little use in lamenting what might have been, Government was unwilling to work its priceless property on commercial lines, thinking the purchaser would have relieved it of this duty. He has not done so, and if Government will even now undertake this responsibility it will in another 60 years find that it has tapped a gold mine with the profits of which those of its other great property, the Indian railways, will not compare. It took some little time to understand that money could be made out of railways, and during that time Government was anxious that private enterprise should take the risk and make the money—it sees differently now. To be the possessor of a valuable property such as the State forests, to undertake only the scientific side of its development and to let its commercial development and the profits thereon go to private enterprise would be to betray a great trust. A far-seeing Forester has already suggested running the property by means of forest loans, just as railways are exploited, and to our mind the suggestion could not be improved upon.

Mr. Pearson clearly recognises the need now of a strong commercial side to the service and suggests that outside business-men be engaged to undertake these duties, leaving forest officers, as before, to continue their work on the technical side only. Except as a temporary measure to bridge the time during which a reorganisation of the Department is being effected, we cannot say we fall in with this suggestion. We should like, on the

contrary, to see a commercial agency established within the Department itself. Look at State Railways · has it not a technical side and a commercial side working together with the greatest success? The Engineering, the Locomotive and the Accounts are the technical departments, the Traffic and Stores the commercial departments. There was a time when it was thought the two latter might be recruited anyhow, but it is not so now, the men in them are being selected for their business qualities, and in the Traffic Department the best railways are now making a further separation between those who look after transportation and those who look after trade. Let us go further than Indian State Railways merely and see what the trend is in connection with specialisation. In the whole field of engineering, whichever the branch be, it is now being recognised that the technical and commercial sides should be kept distinct. The problem is to determine whether to the technical training there should be tacked on a certain amount of commercial training, or the reverse; whether without adding to present burdens, something should be curtailed from the education in either, leaving this something to be made up somehow by application in later life. To ourselves the best solution appears to be that a clear recognition be made from the beginning of what the career is to be and the training for that career be given. If a man, for instance, is to be a commercial engineer, his technical knowledge of engineering need be only limited while his knowledge must be extensive. Similarly in the Forest Service what we feel ought to be worked up to is a strictly technical branch and a distinct commercial branch, the training for which need not embrace a very detailed knowledge of forestry. This latter branch should be organised in this country and should work side by side with the technical branch, just as the Traffic branch of State Railways works side by side with the Engineering branch.—[*Indian Engineering*.]

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I fear, be the comparatively worthless bamboo. In view, however, of Mr. Ribbentrop's opinion and as results are doubtful, only part of the area should be treated as suggested.

[NOTE.—It is hoped that if the above experiment is carried out, the results will be communicated in due course, so that the experience gained may not be lost, and that the method of burning, if successful, may be applied under similar conditions elsewhere.—HON. ED.]

ROOT-ROT OF CONIFEROUS SEEDLINGS.

Authenticated cases of death of trees from root-rot caused by lack of oxygen in the soil, *i.e.*, from asphyxiation, are not common. Hartig * has described an example of such a condition occurring in young thirty-year-old Scotch pines in Germany, where, according to him, circulation of air in the soil became more and more restricted due to conditions incident to forest growth, resulting eventually in the practical exclusion of air from an argillaceous substratum.

The writer has seen cases, of large tulip trees, *Liriodendron tulipifera*, L., dead from this cause near Lakes Toxaway and Fairfield, North Carolina. Both of these lakes are of quite recent artificial origin, and it is probable that by their formation the water-table in the immediate vicinity was so raised that the roots of the tulips in question were drowned out.

The suffocating effect of piling large quantities of earth upon the roots of trees during building or road-cutting operations is becoming better understood in this country, as evidenced by the increasing number of cases where "wells" are built around such trees in order to provide for the maintenance of an air communication with the roots.

In the diagnosis of tree diseases, one is often tempted, when a visible cause is not apparent, to locate the seat of the trouble in the roots. But in large trees an examination of the roots for direct evidence is usually difficult. With young seedlings, however, the case is different, and on this account the trouble about to be described in this paper deserves notice.

* Hartig, *Text-book of the Diseases of Trees*, pp 276 278, Eng. Ed., 1894.

The disease in question appeared in the nursery of the Yale Forest School during the spring and early summer of 1914 and was particularly destructive. Besides the loss of about twenty per cent. of a bed of one-year-old red pines, *Pinus resinosa*, Ait., and five per cent. of a bed of one-year-old white pines, *Pinus strobus*, L., several thousand two-year-old red pines succumbed, as well as a few seedlings of one-year-old hemlock, *Tsuga canadensis*, (L.) Carr.

The disease first became noticeable through a dark red or reddish brown colouration of the tips of the leaves. In the initial stages the contrast of this dark red colour with the remaining deep green of the leaves was very striking. By slow degrees, extending over an interval of several weeks, the red colour extended throughout the entire leaf to its base. Subsequently the reddish hues changed usually to browns, or yellow browns, and the final colour was, in most cases, some shade of yellow, although often intermixed with reddish tints.

A long period—at least a month—was required for this sequence of colour changes; and, at the end of this time, in case the disease had proved fatal, the whole plant was stiff, dry, and entirely dead.

When the disease was first critically examined early in May, it was suspected that the leaves had sustained a fungous trouble of the nature of the well-known *Schutte-krankheit*, both because of their discolouration as well as from the fact that the diseased plants appeared to be located in more or less irregular patches scattered throughout the beds. However, examinations of the discoloured leaves, even on plants where the disease had progressed far, failed to disclose any fruiting bodies or mycelium of a fungus, nor did incubation succeed in bringing to light any pathoganic form.

It was evident that the patches of diseased seedlings were almost always situated in slightly sunken portions of the beds, as well as along their margin, where drainage was poorest.

Diseased seedlings which had been carefully uprooted revealed a root system that was almost without exception entirely dead. This was the case even when the leaf discolouration had not yet

started in, the only evidence of trouble being in the failure of the terminal bud to unfold and develop the leaves of the year. These conditions, joined to the fact that where the discolouration had appeared it uniformly commenced at the *tips* of the leaves, clearly indicated a root trouble of some sort.

That this root trouble was not of fungous origin, but was due primarily to unfavourable soil conditions, was borne out by the following considerations :—

1. Repeated attempts to isolate from the roots a pathogenic fungus or fungi as causal organisms were always attended with negative results. These experiments consisted of (1) incubation in moist chambers, of roots which had recently died, (2) insertion of the inner portions of diseased roots removed with a sterile scalpel, in nutrient agar, and (3) placing such roots, whole, in nutrient agar. In every case no forms appeared except saprophytic fungi, and bacteria which were presumably saprophytic. One fungus which was kindly identified by Mrs. Flora W. Patterson, *Cylindrocladium scoparium*, Morgan,* was of such general occurrence that it was viewed with suspicion, but inoculations of healthy seedlings in sterilised soil with this form gave only negative results.

2. The soil of the seed-beds was stiff and clayey, and although a considerable amount of leaf mould had been added to it, there was still a very small proportion of humus. As a consequence its porosity was slight, and in rainy periods the water would stand for some time in the hollows and poorly-drained parts. Such conditions would naturally prevent a free access of oxygen to the roots, and would therefore readily promote root-rot.

3. The disease caused most havoc during the months of March and April, when the soil was still soggy from the winter freeze and rains, and when the roots, on the other hand, stood in the greatest need of oxygen for the commencement of metabolic activities incident to the season's growth.

4. In June and July when the soil conditions were much improved over those of early spring, many cases of recovery from the disease were observed, as shown by the fact that new roots

* Morgan, A. P., *Two New Genera of Hyphomycetes*, p. 17 : 190—192.

had developed in the region of the root collar. At this time seedlings which were recovering and forming new roots could be detected very often by a glance at the tops. If these were starting a belated growth, inspection of the root system in every case would reveal usually one or sometimes more new roots, conspicuous by reason of their white colour, their thickness, and origin high up, near the base of the stem. Such recovery, which was of fairly common occurrence, is more in line with a physiological trouble, than a disease caused by a parasitic fungus.

5. The course of the disease was slow, requiring at least a month for its completion. In many cases, even after three months of growth, *i.e.*, about August, the tops still appeared healthy, although the year's growth had not developed and examination of the roots showed them to be apparently dead. Here a considerably longer period would have been necessary before the plants entirely succumbed. A very gradual death of this sort would not be expected if the trouble were due to the attack of a parasitic fungus.

6. In soil of a similar character, in another part of the nursery, which had been thoroughly limed, and contained a generous amount of humus, such a disease had never been known to occur. This soil was loose and porous —never retaining water on its surface for any length of time.

The conclusion is, therefore, that the disease was due to lack of oxygen trouble in a soil which was saturated with water, *i.e.*, that the roots were suffocated.

As already intimated, the remedy would consist in a thorough liming of the soil. Probably this in itself would be sufficient, but the addition of more humus would also improve the physical character of the soil as well as benefit the plant growth directly.
[ARTHUR H. GRAVES *in Phytopathology*, Vol. V., No. 4, p. 213, 1895.]

PRICKLY PEAR.

The question of treating prickly-pear in such a manner as to make it suitable fodder for cattle seems to have been dealt with in a practical way by the Bombay Department of Agriculture. The problem was to get rid of the spines of the plant by some less expensive method than cutting by hand; and liquid flame has proved to be the best agent. We know how this has been employed in the present war; but its use in the peaceful field of agriculture came before the days of "frightfulness." In Texas great success was gained by a " pear-burner " and one of these was tried in 1914-15 in the Bombay Presidency. The burner is described as a 2-gallon vessel from which a metal lance tube leads to a vapouriser four feet away. An air pump is attached to the vessel which is filled two-thirds full with petrol. Then air-pressure is applied by the pump and the petrol is driven out of the vapouriser. When a light is applied a jet of flame is projected and the prickly-pear is sprayed The spines only are burnt off and the plant itself is not damaged The cattle have to be taught to feed off the pear after treatment, but presumably this is a simple matter. The official verdict is that the burner promises to be invaluable in the case of a fodder famine in the East Deccan, and as its cost is only Rs. 68-2-0 landed at Poona wide employment seems possible. Great care has, of course, to be exercised owing to the inflammability of petrol, but an intelligent cultivator should readily learn to handle the machine with safety to himself.—[*The Pioneer.*]

CACTUS GUM.

New wealth from the desert, in the form of some valuable cactus product, is being looked for at the University of Washington. A quantity of dried cactus contains much resinous material, the properties of which are to be fully investigated. Whether the material is a true gum, soluble in water, or a resin, soluble in turpentine and alcohol, was not known at the outset of the experiments. [*Capital*]

FORESTRY IN INDIA.

ENTRY INTO THE SERVICE.

Sir Sainthill Eardley-Wilmot, K.C.I.E., writes in the *India man*:—

The Indian Forest Department has been reorganised during late years, and now presents to the youth of the Empire much greater attractions than in the past. It has survived half a century of neglect and opposition, during which its members suffered from isolation in unhealthy districts, wretched pay and poorer prospects, and has now reached a stage when fuller recognition is given to those who are managing a vast and well-organised estate intimately connected with the agriculture and industries of the country.

The extension of railways and the increase of population has remedied to a great extent the loneliness of the past, and the opening up of the forests and the construction of roads, houses and wells have so improved the sanitary conditions that, apart from the slight risks always facing the pioneers of civilisation, the forester, as a rule, is not called upon to endure greater hardships than his fellow-workers in other branches of the Civil Service.

As to salaries, the Indian forester now begins his career on pay and allowances which enable him to live in comfort and independence, while the system of annual increments of pay ensure that, provided he behaves like a gentleman and is an efficient forester, he will be in receipt of a salary of £1,000 a year before he completes his twentieth year of service. During the whole of that period, and thereafter, his professional success must depend on personal energy and ability.

The complaint that the forester in India is denied the interest of real professional work is no longer valid. He will find that the forests in his charge are managed in terms of carefully prepared working-plans, or that he is employed in compiling new plans or revising those about to lapse. He will discover that he has to puzzle his brains to some extent if he proposes to teach his seniors anything in the way of sylviculture, transport, contracts or utilisation, and his patience will be sorely tried in administering the records-of-rights and in remaining in sympathetic touch with

the neighbouring inhabitants, on whose good will largely depends the success of his operations.

Should the forester's leaning be towards the sciences cognate to the practice of his profession, his attention will be attracted to the Imperial Research Institute at Dehra Dun, where special opportunities are afforded for the study of chemistry, entomology, botany, engineering, etc., and whence issue from time to time the results of forestry research in India in the form of memoirs, bulletins and records. There also, if his interest is awakened in forestry education, he will be able to make acquaintance with the system adopted for the training of Indians for the service. In short, on arrival in the country he will find himself attached to a forestry organisation superior to anything in the Empire or its dependencies, and which should become, by the exertions of the men now joining, at least equal, if not superior, to anything of the kind in Europe.

Of hobbies, sports and pastimes connected with a forest life it seems unnecessary to write, for the forester will select these according to his taste. When indulged in the proper spirit they add to his power of observation, take him to localities perhaps otherwise neglected, and bring him into more familiar contact with the people. They may also ultimately create in him an absorbing interest in botany, entomology or other speciality which may be of the greatest advantage to his professional worth.

PROSPECTS.

The advantages recently conferred on the Forest Department have necessitated naturally a more careful selection of its members. Candidates must have obtained an honour's degree in pure science at a University before they can appear before the Selection Committee which sits yearly at the India Office. After selection they must specialise in forestry at a University approved for this purpose by the Secretary of State for India—at present Edinburgh, Oxford or Cambridge—and obtain either a degree or a diploma in forestry, according to the system adopted by the institution selected. Practical training has been carried out in the past

partly in this country and partly on the Continent. It is hoped that it may be possible in the future to eliminate Continental training when State demonstration areas are fully organised at home, more especially as present conditions on the Continent enforce this step whether home organisation is complete or not. It will be unfortunate, however, if visits to Continental forests continue to be impossible, not because the methods there adopted can be slavishly copied in India, but because the forester may learn how to apply some of the unalterable rules of sylviculture to those Indian conditions to which he must conform whether his work takes him to the north, south, east or west of the peninsula.

The choice of a University in which the candidate for the Indian Forest Service will commence or complete his special education depends largely on his own tastes and on the means of his parents. Edinburgh and Oxford in normal times have each about fifty forestry students on their rolls. Cambridge, on the other hand, attracts fewer. The expenses at Edinburgh are about one-half of those inevitable at the two English Universities, and while Scotland, of course, gives larger scope for practical training than does England, Edinburgh, also, possesses a forestry building with class-rooms and museums on a much larger scale than either Oxford or Cambridge. Of the social conditions each one must be his own judge. Perhaps it would be correct to say that in the north class distinctions amongst students are not so noticeable, and that in Scotland, as on the Continent, a forester receives a special welcome as belonging to a profession in which very many landowners are personally interested.

Finally, to a youth considering a life-long foreign service there are matters of leave and pension of great importance. With regard to the former, the rules are liberal, being similar to those of all civil departments in India. The pensions, however, are inadequate. They culminate in a yearly sum of £525, which may be earned ten or more years before the completion of service, as defined by the age-limit, and thus the attainment of the highest rank in the department does not bring with it, as in other services, an increase of both comfort and dignity. It is true that there is a

provident fund in which an officer may invest a considerable proportion of his salary at good interest and with perfect security, but it still remains evident that an improvement of the pension rules is necessary in order to complete the reorganisation of the terms of service, which otherwise are on favourable lines.

Writing as one who joined the Forest Department in its infancy and left it when the strenuous work of improvement was almost complete, I think it is correct to say that the service as now constituted offers a career suitable to such sons of the Empire who possess self-reliance, are not afraid of responsibility, and desire a fair outlet for their energy and ability. With these ordinary qualifications an Indian forester of the present day may lead a life free from financial worry and full of interesting work and relaxation.—[*The Leader.*]

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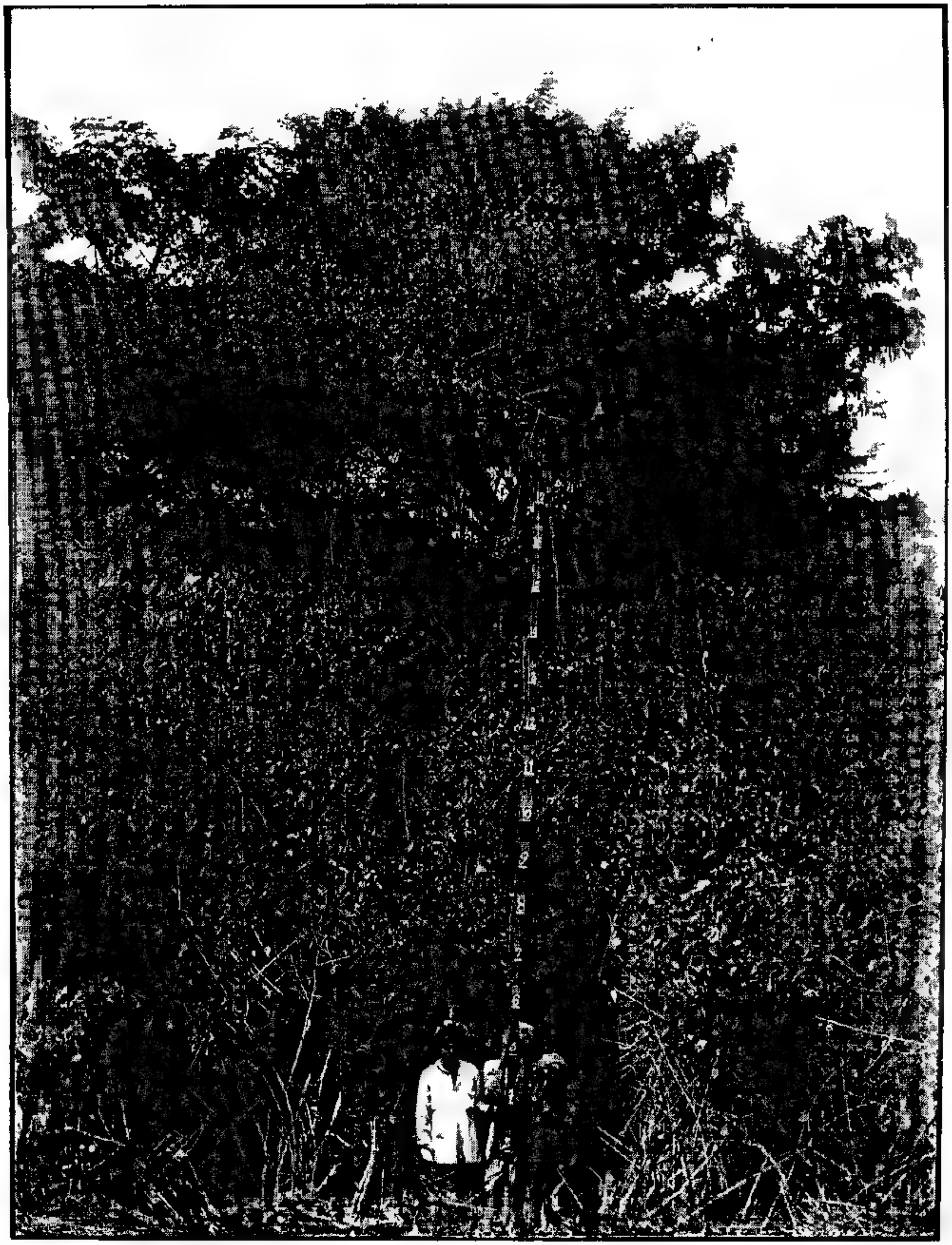
LANTANA IN THE FORESTS OF COORG.

BY H. TIREMAN, DEPUTY CONSERVATOR OF FORESTS, COORG.

(Illustrated by Plates I, II, V and VII (Plates 34 to 37); Plates III, IV, VI and VIII have not been reproduced.)

At the meeting of the Board of Forestry in 1913 a paper was read by Mr. Lodge on prickly-pear and lantana in Madras and the subject was discussed by the Board. The President, Mr. Beadon-Bryant, referred to the conditions prevailing in Coorg and stated that eradication of lantana had been commenced. The following note on the progress made in the eradication of the pest, and on the results obtained may be of interest:—

In January 1912 Mr. Beadon-Bryant made a tour of inspection in the Coorg forests and amongst other matters he investigated the question of the eradication of lantana In his note on the subject appended to his "Note on an Inspection Tour in the Forests of Coorg," dated 1st February 1912, he described the process which is taking place, and showed that it was only a



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LUXURIANT GROWTH OF LANTANA.

question of a comparatively short time for the forests to become pure useless lantana wastes. He advocated—

(1) the abandonment of fire-protection in the forests most seriously affected;

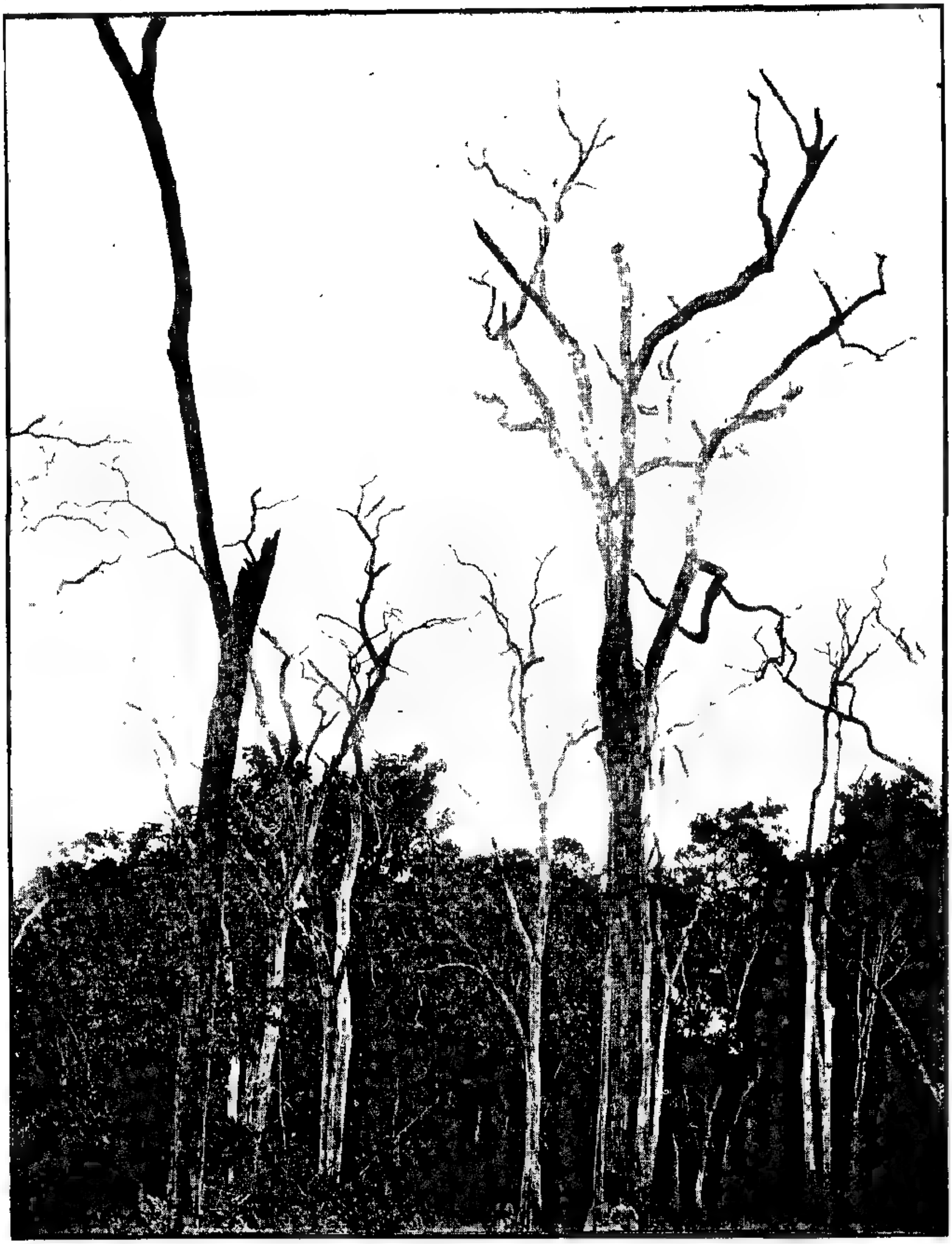
(2) uprooting the lantana after it had been burnt; and

(3) sowing the seeds of valuable species after the lantana had been uprooted.

In such waste lands ("Paisaris" and "Banes") as contain much sandalwood Mr. Beadon-Bryant advocated uprooting the lantana without previously burning it, in order to avoid damaging the sandalwood. He further considered that the sudden exposure of the sandal by the removal of the lantana might possibly injure or even kill the trees, and advocated the conducting of experiments to prove how the lantana can best be removed without causing damage to the sandal.

2. Plate I (*vide* Plate 34) gives some idea of the dense manner in which the pest grows in Coorg. Practically all the vegetation *seen in the photograph is lantana; it is growing round and up* an *Albizzia Lebbek* tree. When it is borne in mind that in a dry year lantana burns freely when green, some idea is obtained of the damage caused by such fires. It is naturally impossible to beat out a lantana fire once started. Plate II (*vide* Plate 35) shows the damage to tree-growth which has been caused by two such fires which occurred in 1909 and 1911. In the latter year, as there had been no fire in 1910, the lantana had almost attained its previous density

3. As a result of Mr. Beadon-Bryant's visit, a grant of Rs. 15,000 was made in 1912-13 and operations were commenced on a considerable scale. It was hoped that as the destruction of the lantana would greatly benefit the local ryots owing to the removal of the harbour which it gives to elephants, tigers, panthers, and pigs, local labour on a considerable scale would be available, and it was estimated that in these circumstances it would be possible to carry out the work of eradication for Rs. 6 per acre. The local ryot however is comparatively well off, and is one of the laziest people in the country, and it was very soon



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DAMAGE DONE BY LANTANA FIRES.

found that in spite of the willing co-operation of the Commissioner (Mr. Harris) and his Revenue officers and of the offer of free-grazing as a reward for good work the local people were absolutely useless. They would not work six hours a day. It was in consequence necessary to employ contractors who worked chiefly with imported labour which has to be paid higher than the local rate. Owing to the delay incidental to obtaining contractors no great progress was made during the first year.

4. During 1913-14 an allotment of Rs. 25,000 was sanctioned. Contractors came forward freely, and the majority of the work has since been carried out on contract. The rate paid is usually from Rs. 7 to Rs. 8 per acre, but in some cases where the lantana was especially dense as much as Rs. 12 has been paid. The original estimate of Rs. 6 per acre omitted to make provision for uprooting the regrowth springing up after the first uprooting. All kinds of prognostications were made by local residents. I was told that the regrowth would be so vigorous that it would cost Rs. 30 per acre to get the land clear; that lantana is spread at such a terrible pace by crows and other birds, that as fast as I uprooted it, it would be resown by this agency: that if lantana were burnt it would come up again much thicker than ever it was before; and that, like the carpenter, I ought to weep, as it was doubtful if I should ever "get it clear."

5. Actual facts have, however, given the lie to these prophets of evil. After four years' experience of the work I am convinced that the pest does not spread nearly as fast as is imagined and the reason why it has invaded such a large extent of the Province in such a comparatively short space of time is that it was looked on as an excellent hedge and was planted everywhere for fencing purposes. As regards the allegation that burning makes it grow thicker than before, this has been found to be true on perhaps two or three per cent. of the area burnt. In by far the majority of cases the seeds lying dormant in the ground appear to be killed by the fire, and a large number of stems are either killed outright, or are so damaged that they can easily be pulled up after a little rain. Repeated burning, however, is necessary, as if burnt lantana cannot be uprooted in the same year it very quickly recovers its vigour.

6. If the work is properly done during the first year the average cost of uprooting regrowth in the second year varies from 12 annas to Re. 1-8-0 per acre, in the third year it is about 6 annas and in the fourth year slightly less. In the fourth year, however, provided there is a fair canopy overhead, there are so few seedlings that the greater part of the expenditure is incurred on searching for them, and I think it is better to confine the fourth year's work to burning the area, unless the experience of the fifth year shows that the number of seedlings surviving is serious.

7. The method adopted has, for the most part, been to cut the lantana a foot or so above the ground level, to roll it away from the stumps, and then to dig up the stumps with a mamoty. The plant is very shallow rooted, and the roots come away easily when the ground is soft. A good many of the stumps can be pulled up *by hand without the use of any tool, but this is hard work and the* coolies prefer to dig up practically everything. The work requires a great deal of supervision, as if the contractors are not carefully watched they cut off the roots just below the ground surface. With careful inspection, however, it is fairly easy to see whether there is a reasonable quantity of roots in evidence, and as a part of the payment is deferred until sufficient rain has fallen to cause any roots left in the ground to send up shoots, contractors are beginning to find that cutting off the roots below the ground is not a paying proposition. Plate III (*vide* Plate 36) showing the heaps of uprooted lantana gives some idea of the amount of work involved.

8. The work would be considerably reduced if the lantana were cut at the end of the rains without being rolled into heaps, and burnt in the hot weather. It can be done fairly easily by men crawling under the thicket and cutting the stems of the larger plants. It costs about Rs. 2 per acre. This method has hitherto been tried only on a few small areas, and has not been particularly successful owing to the large number of seedlings springing up in the rains. It is probable that two or three annual fires are necessary before the cutting is undertaken in order to kill the seeds lying dormant in the ground, but at the same time it has also been found that on a small proportion of the area burnt without cutting,

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Advance growth of *Anogeissus latifolia*.

... was covered with dense Lantana until it was cleared in 1912.

numerous seedlings similarly spring up, and it may be that if the method is adopted on a larger scale it will be found on the whole to be successful. In this event matters will be greatly simplified, as a large amount of the work can be done in the dry weather when labour is fairly plentiful, and uprooting is out of the question owing to the hardness of the ground.

9. Fire is a most useful auxiliary in the campaign against lantana. Repeated fires not only actually kill a number of the plants, but they prevent the lantana from becoming dense. The result of continued burning is that owing to the reduction of the density of the thicket young teak and other valuable species which are lying suppressed under it are enabled to spring up. Plate IV (*vide* Plate 37) shows an area which has been repeatedly burnt, with some teak seedlings coming up through the gaps in the thicket The lantana in this area was four years ago a dense tangled mass through which an elephant would have had difficulty in forcing its way. No clearing has been done, though for the purpose of taking the photograph two or three lantana branches were cut.

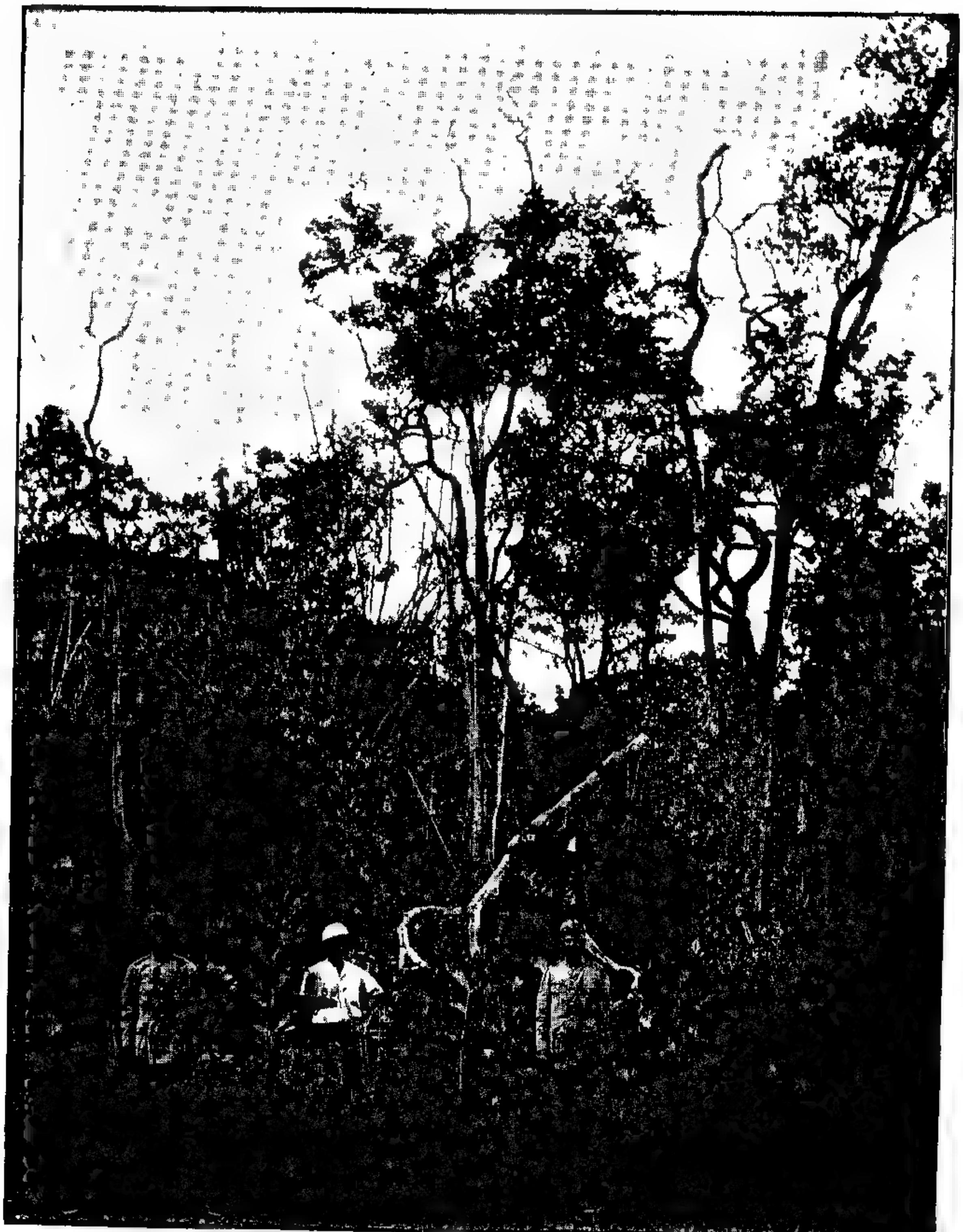
10. It may be argued that fire is too drastic an agent to use in a forest owing to the damage done to the tree-growth. It is, however, a case of ways and means. If the lantana is not burnt before it is uprooted, it must be burnt in the dry weather following the uprooting, as otherwise the cost of eradication is prohibitive, as a mass of seedlings springs up round every heap of débris, and the presence of this debris renders it very difficult to get at the seedlings to uproot them. Without fire the cost would probably be doubled. Further, in most cases the damage had already been done by the fires of 1909 and 1911, and the additional damage done by the subsequent annual fires has been comparatively small.

11. It has been found unnecessary to carry out the sowings which Mr. Beadon-Bryant advocated, as the result of removing the lantana has been a wonderful springing up of seedlings of teak and other valuable species The lantana does not appear to prevent germination to any extent, and as it keeps the ground absolutely clean the radicles of the young plants have no difficulty

in finding their way into the soil. Numbers of seedlings have evidently been living suppressed under the lantana unable to do more than keep alive, but apparently not losing their vitality, and as soon as the thicket is removed they spring up most vigorously. This has occurred to an extraordinary extent in the case of *Anogeissus latifolia*, as shown in Plate V (*vide* Plate 36) where the mass of vegetation seen up to a height of 9 feet is pure *Anogeissus* advance growth. In 1912, this area was a dense mass of lantana. Young seedlings are further favoured in the first year or two after the removal of the lantana in that where the lantana has been well burnt, a considerable time elapses before grass begins to grow, and the seedlings have a chance of establishing themselves. In parts of the Anekad forest where the lantana used to be particularly thick and was cleared in 1913, the state of the natural reproduction is—for a South Indian teak forest—extra ordinarily good. This forest will now require considerable attention in the way of improvement fellings and cleanings to favour the young growth. If work on these lines is properly carried out there is every prospect that the forest will, in time, be considerably better stocked than it was before the lantana invasion.

12. Plates VI (*omitted*) and VII (*vide* Plate 37) show the young teak and blackwood which has resulted from the removal of the lantana. In the area shown in Plate VI (*omitted*) the lantana was removed in 1914, in that shown in Plate VII (*vide* Plate 37) in 1913. In the former case practically no weeding was done for the purpose of the photograph, in the latter case as most of the surrounding trees are dead and there is hardly any shade, a good deal of annual weed had sprung up, and had to be cleared.

13. Plate VIII (*omitted*) shows a piece of ground cleared of lantana in 1913, with blackwood and "honne" (*Pterocarpus Marsupium*) seedlings in the foreground and lantana still to be cleared in the background. Practically no weeding was done in this case. The plate shows the contrast which, after being cleared, land under a forest canopy presents to its previous aspect under lantana. It is difficult to show this clearly in a photograph, but it is a remarkable feature of the lantana operations. It is almost



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Natural reproduction of Teak on ground cleared of dense Lantana in 1913.
Note damage done by previous fires.

impossible to realise that the cleared areas ever contained any lantana.

14. Mr. Beadon-Bryant's fear that the sudden removal of the lantana surrounding sandalwood trees might injure or kill them has not been justified. They do not appear to suffer in any way. The areas treated however for the most part contained a sprinkling of other trees which probably afford sufficient shade to give the necessary protection to the sandalwood.

15. Mr. Beadon-Bryant advocated uprooting the lantana, where there was much sandalwood, without previously burning it. I know, however, of only a few areas in Coorg where there is much sandal wood and where the lantana has not been constantly burnt. They cover about 600 acres. There is, in these cases, a large quantity of sandalwood standing in dense lantana, and if fire is used here the loss will be very serious. It will be necessary to uproot it and roll it away from the sandal trees. The cost will be high but having regard to the value of the stock of sandalwood it will be justified. Elsewhere as a rule the damage has already been done and annual fires cannot materially add to it.

16. The area cleared of fairly dense lantana up to date amounts to about 5,500 acres of Reserved forest and 2,200 acres of waste lands and in addition about 7,800 acres of Reserved forests have been cleared of scattered lantana. The cost incurred has been about Rs. 68,000. To render these areas absolutely free of regrowth will perhaps cost some Rs. 15,000 more, and it may possibly be necessary for some years to come occasionally to inspect them until it is found that there is no possibility of a recrudescence.

17. In Mr. Lodge's paper read before the Board of Forestry in 1913, he stated that in Madras elephants had been employed to pull up lantana. This method was also tried in Coorg some years ago, but the employment of elephants is out of the question on any large scale and in any case they cannot compete with the cooly.

In paragraph 13 of his paper Mr. Lodge referred to the difficulty of finding anything that will grow through and kill lantana, and stated that it was believed that lantana would not grow under Castor. I have found nothing (except fire) which will

actually kill it, but evergreen forest—if fire is kept out—will, in the course of perhaps fifteen or twenty years, grow through the lantana and suppress it, though the lantana does not die. Castor I have found to check the growth of lantana considerably, but it does not kill it.

18. In accordance with Mr. Beadon-Bryant's instructions a regular scheme has been drawn up for clearing the whole of the eastern forests, and the greater part of the sandal-bearing waste lands. The total cost has been estimated at Rs. 4,40,000. A small area of waste lands still remains to be examined, and in all probability the total cost will be approximately 5 lakhs of rupees. It is a large sum, but as Mr. Beadon-Bryant said it is a choice between forest and lantana. The work is proving to be very beneficial to the forest growth, it is undoubtedly of great benefit to the general public, and there is every likelihood that the cost of the operations will be more than recouped by the additional revenue to be expected from the increase in the stock of sandalwood which should result from the removal of the cause of the fires which at present do so much damage.

A NOTE ON THE AFFORESTATION OF THE TELANKHERI HILL (ALSO CALLED THE SEMINARY HILL), NAGPUR.

BY S. SHRINIVASULU NAYADU, EXTRA DEPUTY CONSERVATOR OF FORESTS, NAGPUR-WARDHA DIVISION, C. P.

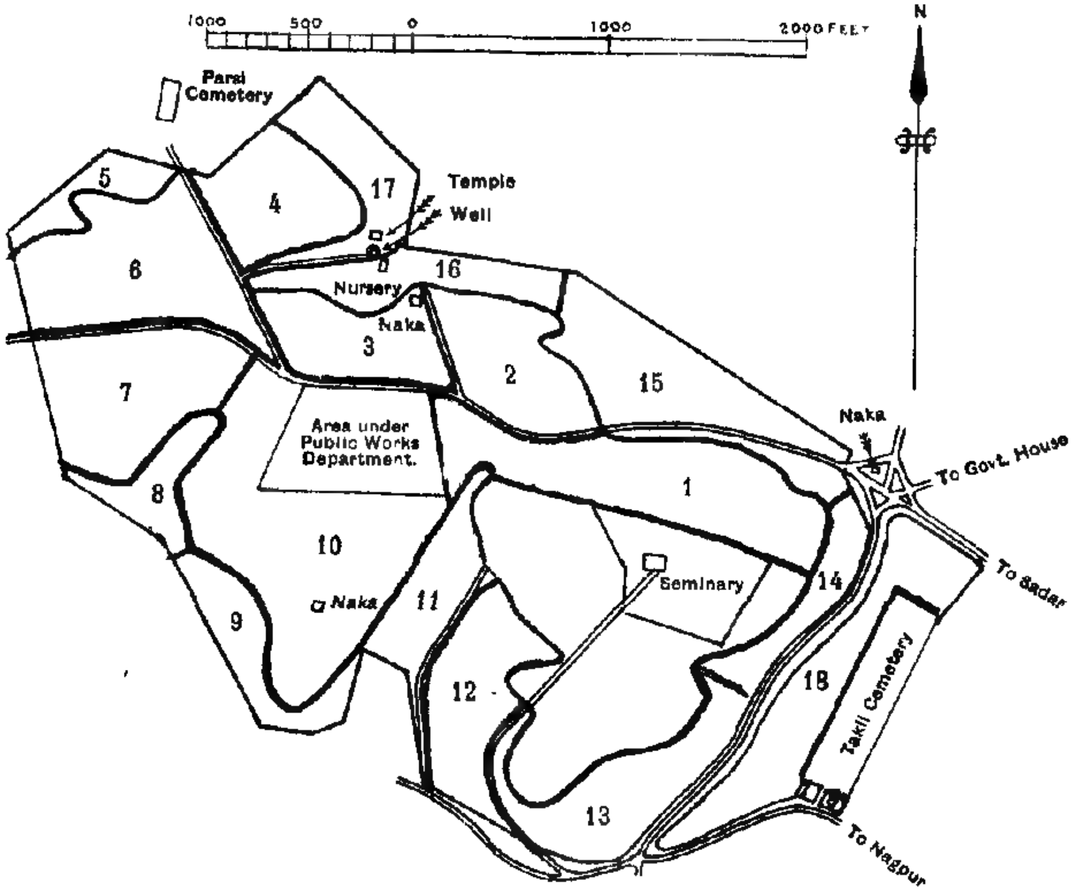
Introduction.

A contribution describing the preliminary operations by Mr. Hore appears on pages 69 to 78 of the issue of the *Indian Forester* for January and February 1910. The present note is a description of the result of those operations as well as those carried out since that time up to date (end of September 1915).

2. The writer claims no originality in respect of the measures adopted with success, as they have been the outcome of a study of experimental work initiated by Mr. G. M. Townshend, I.F.S., and the suggestions and criticisms of several Conservators under whose technical direction the plantation is managed by the

MAP
OF THE
TELANKHERI HILL PLANTATION, NAGPUR.

Scale of Feet.



REFERENCES.

Area under Forest Department
Compartment Boundary
Compartment Numbers .... 1-2-3 Etc.
Wire Fencing

Area Statement.

	Compartment Number.	Area in Acres.	Remarks.
Plateau.	1	18·0	
	2	9·0	
	3	9·9	
	4	10·2	
	6	15·4	
	7	14·6	
	10	25·8	
Slopes.	5	3·1	
	8	4·5	
	9	6·8	
	11	6·9	
	12	9·5	
	13	10·7	
	14	5·8	
	15	16·2	
	16	7·8	
	17	5·7	
Plain.	18	18·2	
	19	0·8	
	Total.	198·4	

officer in charge of the Nagpur-Wardha Division. Thus the amputation of the stems of Sissu during transplantation, when the roots require pruning, was done at Mr. Clutterbuck's suggestion, while the system of dry cultivation which is giving such marvellously good results, was due to Mr. Trafford's initiative. Owing to the excessive cost of the operations they may not be of particular value in forests where obviously only favourable localities are selected for treatment, but the operations teach a lesson as to the tremendous outlay and trouble required to create a forest where one has been destroyed.

PART I.—GENERAL DESCRIPTION.

Object of the scheme.

3. This hill which was practically bare is situated in the middle of the Civil Station of Nagpur and touches the cemetery gate of the Government House. Clothing it with trees is therefore beneficial both from the climatic and artistic points of view.

Area.

4. The tract is 198·4 acres in extent and is subdivided into 19 compartments as shown in the enclosed map (Plate 38).

Configuration.

5. The area presents three main physical features comprised as follows:—

	Nos.	Acres.
1 Plateau compartments (about 75′ above plains-level).	1, 2, 3, 4, 6, 7, 10 .	102·4
2 Slopes do do ...	5, 8, 9, 11, 12, 13, 14, 15, 16 and 17.	77·0
3. Plain at foot of hill ...	18 and 19 ...	19·0

Compartment No. 18 was added in 1912 and No. 19 in 1913.

Cultural characteristics.

6. The area rests on partially disintegrated trap rock known locally as 'muram.' This disintegrates rapidly when exposed, but when not so exposed, it forms, together with the boulders imbedded in it, a hard pan, difficult for the roots of trees to penetrate. Beds of unfissured

hard rock appear at the surface close to the base of the slopes, particularly in compartments 11, 12, 13, 14 and 18.

7. When properly oxidized the disintegrated trap yields a red or black clayey loam which is fertile, but when not completely oxidized it yields a coarse grey detritus which is the reverse.

8. On the plateau the 'muram' forms a hard pan superposed by a thin layer of black soil. The major portion of the slopes has been bereft of surface soil by erosion and heavy scraping for 'muram' for the roads. We find therefore here no soil to speak of except in portions which have escaped denudation, *viz.*, compartments 8, 9 and 11 where the soil is a reddish loam, and 15, 16 and 17 where it consists of a grey coarse-grained material. The plain below the hill, compartments 18 and 19, has also been so heavily scraped that the underlying hard rock is laid bare over nearly half its area. The soil, though consisting of the grey coarse-grained stuff, contains some silt in places, owing to the existence of a stream traversing the area.

9. Except compartments Nos. 5, 17, 16, 15 and 11, the slopes present unfavourable aspects, *viz.*, western, southern, south-western and south-eastern and are consequently exposed both to the hot sun and severe hot winds from April to June.

10. Nagpur ranks among the hottest places in the Province. The rainfall is about 45 , but as this is confined generally to the months of July, August and September the growing season is short.

Past treatment.

11. Some 17 years ago endeavours seem to have been made to afforest this hill. The particulars of the work, which was not entrusted to the Forest Department, are not available, but a patch of stunted teak and *Terminalia tomentosa* in compartment No. 1 and a strip of dwarfed Khair fringing the top of the slope in compartment No. 14 bear testimony to the work then done. The method employed seems to have been strip sowings.

Trees, chiefly Nim, planted by private bodies, such as the Roman Catholic priests living in the Seminary and the Parsi community, who have their cemetery on the hill, are fairly flourish-

ing, though they appear incapable of exceeding a girth of $2\frac{1}{2}'$ to $3'$, and a height of about $20'$ and develop crowns with only a small to medium spread.

Considering the nature of the difficulties that have to be surmounted our obtaining similar results would not be unsatisfactory.

PART II. PRESENT TREATMENT.

12. These were confined to the slopes and the plains portion and consisted of, on the slopes (i) the construction of dry boulder dams across the ravine to check the flow of rain water and arrest silt and (ii) the excavation of a continuous catch-water drain with a section of $3' \times 2'$ along the top of the slopes a little below the crest. Both these devices have proved beneficial, the second in arresting surface floods which would otherwise have continued the denudation of the slopes.

Operations for the improvement of the soil.

13. The third operation, which was common to the worst slopes, *viz.*, compartments 12, 13 and 14 and compartment 18 of the plains portions, consisted in the construction of dams of earth *with waste weirs at suitable places, somewhat on the lines of the* Italian system of " Colmate del monte," the main idea of which is to secure the silting up of the hollows by increasing the erosion of the ridges. Except where the ground at head-waters is cultivated, silting up in trap countries is a slow process and in this plantation the ground above, intercepted by the dams, could not be ploughed up owing to the existence of established seedlings that had already come up on the interrupted trenches. Thus the system, which has full justification in agricultural tracts, not only proved useless here, but even directly hurtful, inasmuch as the soil, which would otherwise have helped to hold up moisture, was removed to build the dams.

14 The methods commonly known to Foresters of direct sowings, such as sowings in strips, trenches, pits, etc., were therefore continued unaffected.

Preparation of the soil.

15. *On the plateau.*—Originally the idea was to make trenches $1' \times 1'$ about $20'$ apart, work up the excavated soil, bank the same alongside the trench and sow seed of hardy species on the bank. In addition to these, pits $5' \times 5' \times 5'$ about $40'$ apart were to be made and filled up with good soil, for road-side planting, and pits $3' \times 3' \times 4'$ distributed at intervals singly or in clusters were also to be made and filled up with good soil for planting ornamental trees.

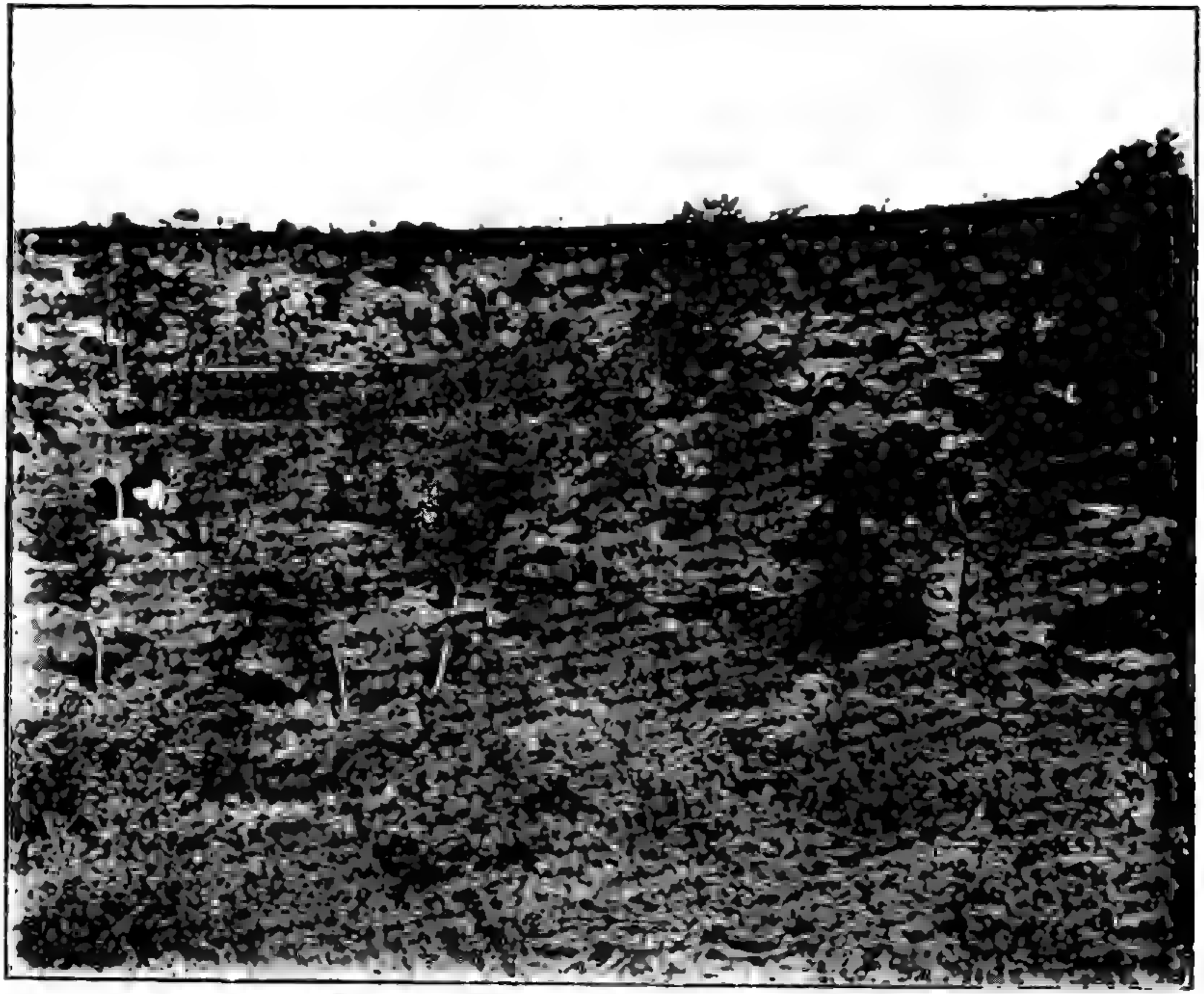
There was some delay in the issue of these instructions and in place of the trenches, strips $3'$ wide and $5'$ apart were made in the rains of 1909. An English turn-wrest plough was used to make the strips, which were also harrowed with a backer. Pits on the road-sides were made of the proper size, but in various other points, aggregating 16 acres, the pits were made as follows:—

$$\left.\begin{array}{l} 1' \times 1' \times 1' \\ 4' \times 4' \times 1' \end{array}\right\} \text{12 acres.}$$

$$\left.\begin{array}{l} 3' \times 3' \times 4' \\ 2' \times 2' \times 2' \end{array}\right\} \text{4 acres.}$$

16. The results as far as the strips were concerned were not satisfactory, though they were re harrowed and re-sown in 1910. The same fate awaited the sowings on pits one foot deep. It was therefore decided to make $2' \times 2' \times 2'$ pits about ten feet apart wherever the strips were blank. This work was pushed on in 1911 and 1912, and as the so-called survivals in the strips continued to die in large numbers, the making of pits is still in progress.

17. A depth of one foot is not sufficient to open up fissures in the pan of 'muram' below and the strips were not even one foot deep while the effect of loosening the shallow soil had been to convert them into furrows or, in the rains, into so many water-courses. Thus in the rains the plants suffered from severe waterlogging, owing to the retentive nature of the soil, while after the rains the almost bare 'muram' hardly gave the plants any strength to withstand the long dry weather that followed. The present plan therefore is (i) to examine and accept as individuals for the future those survivals which are well established, dig up the soil round



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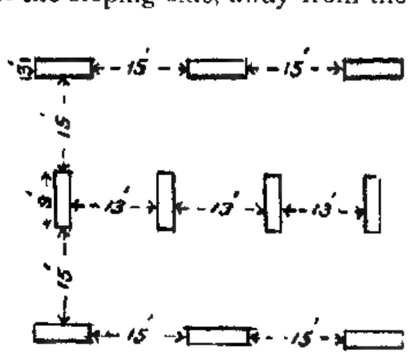
AFFORESTATION OF SEMINARY HILL, NAGPUR, C. P.

them for a radius of about $1\frac{1}{2}'$ to $2'$, collect the soil in a conical heap against the stem and maintain it undiminished and periodically raked, (ii) keep also the soil in the $2'$ cube pits similarly loosened and heaped up and (iii) make, in a similar manner, new $2'$ cube pits about ten feet apart where (i) and (ii) are absent. In all these cases, wherever possible, a channel to drain off water is cut on the sloping side, away from the direction of the old furrow.



18. Trenches $9' \times 3' \times 3'$ arranged as per diagram on margin and filled up with good soil were made in 1913, for starting protection-groves at selected scattered points. The idea was to get the trees to grow rapidly in these groves, whilst to the lee of them other plants were gradually growing up. It was, however, not found possible to remain content with this, owing to the large number of casualties among the so-called survivals in the furrows and in the $2'$ cube pits in which the filling had settled down. A systematic renewal of failures and filling, as described in the preceding paragraph, had therefore to be taken up all over the area.

19. *On the slopes.*—Here the method originally designed, *viz.*, of making interrupted trenches $8' \times 3' \times 2'$, ten to twenty feet apart, more or less along the contours, was not deviated from, except that, by way of completing the stocking $3'$ cube pits are now resorted to, instead of the trenches following the fissures in the rock.

The trenches were at first filled up with surrounding surface soil, which, as already stated, was not fertile, particularly in the worst compartments Nos. 12, 13 and 14. Black soil, brought from outside, had to be introduced into these trenches, in order to stimulate the growth. The pits recently made were all filled up with good soil brought from outside.

20. *In the plains portion.*—Compartment No. 18 adjoins the road leading to Government House. In addition to the heavy

scraping for 'muram' that has taken place in it, the borrow-pits, made for the construction of the dams, have rendered the compartment unsightly. In 1911, therefore, trenches 9′ × 3′ × 3′ were made at intervals of about 20′ along the above road and filled up with a mixture of 'muram' with good soil brought from outside. Groups of ten such trenches were also made and similarly filled up at selected points avoiding the outcrops of hard rock

As this was found insufficient, 2′ cube pits were made in the softer portions of the compartment and filled up with good soil for planting towards the latter part of the rains of 1913. This work was continued in 1914. Pits 3′ × 3′ × 3′ were made, following fissures in the rock below and filled up with good soil brought from outside. These points, being rocky, larger-sized pits were necessary.

21. Compartment No. 19 forms the front of the cemetery. To screen the bare wall of the cemetery and to increase the seclusion of the place orders were received to get up tree-growth here as quickly as possible. Pits 3′ × 3′ × 3′ were therefore made for planting fast-growing species and as a good deal of water percolates from the slopes into this area not far below the surface, drainage channels had to be excavated and each of the pits drained into them by means of smaller channels.

Sowings and plantings.

22. Sowings of a great many species have been tried, but not always with success; for example the selection of mango, Pongamia and Gold mohar for planting on the plateau, where they are exposed to scorching hot winds, was not a happy one. As the object is to grow only shade and ornamental or, to a limited extent, nurse trees, we are rather restricted in our choice of species. The following kinds have been found to give satisfaction :—

Species.		*Locality.*
Hardwickia binata (anjan)	...	On slopes and well-drained portions of the plateau and the plain.
Melia Azadirachta (nim)	...	
Pterocarpus Marsupium (bewla)	...	Plateau and slope in pits where good soil is put in.

Teak	...	On slopes.
Dalbergia Sissu (sissu)...	...	Anywhere.
Albizzia odoratissima (chichwa)	.	Protected slopes.
Boswellia serrata (salai)	...	Slopes.
Terminalia Arjuna (kahu)	...	On margins of the plateau.
Dalbergia latifolia (sisham)	...	Everywhere and on earth dams.
Soymida febrifuga (Rohan)		Everywhere and on swampy calcareous soil.
Bassia latifolia (mahua)	...	Everywhere
Ficus religiosa (Pipal) ...	..	Everywhere
Pongamia glabra (Karanji)	..	Moist plains.
Melia Azedarach (Bakain)	.	
Pithecolobium Saman (rain-tree)	...	

23. As a matter of course sowings *in situ* had to be resorted to to begin with, and it has given most excellent results. It is still largely adopted, though from 1913 a considerable amount of planting has also been done. The faculty of propagation from cuttings of Salai (*Boswellia serrata*) was similarly of great assistance when such a lot had to be done in the beginning, cuttings of this species having been freely planted on the interrupted trenches on the hill-slopes. The majority of them have struck root and are flourishing ready to grow on as principal stems or as nurses to better kinds.

24. Seedlings, a fortnight to a month old, taken from beds in which the sowings *in situ* were too thick, have given satisfactory results. The little seedlings do not suffer much during transplantation, and when removed to freshly-prepared soil make a good start and do about twice as well as those left behind in the original beds.

25. *Having discovered in 1914 that Sissu*, Nim and even Hardwickia plants bear a certain amount of injury to the roots, including the tap-root, the individuals of these species removed in thinnings are being planted with success, wherever quick results are required. The plants in the various pits and trenches being grown *in situ* had not developed a compact mass of roots but

a scattered and deep root-system. It was impossible, therefore, to dig up the plants, without somewhat heavily damaging the main roots. The injured roots were pared off, so as to secure for them clean cut ends, the stem was also cut off, some 3 or 4 inches above the root column. When set down in their final places these cuttings shot up vigorously and continued to grow without watering.

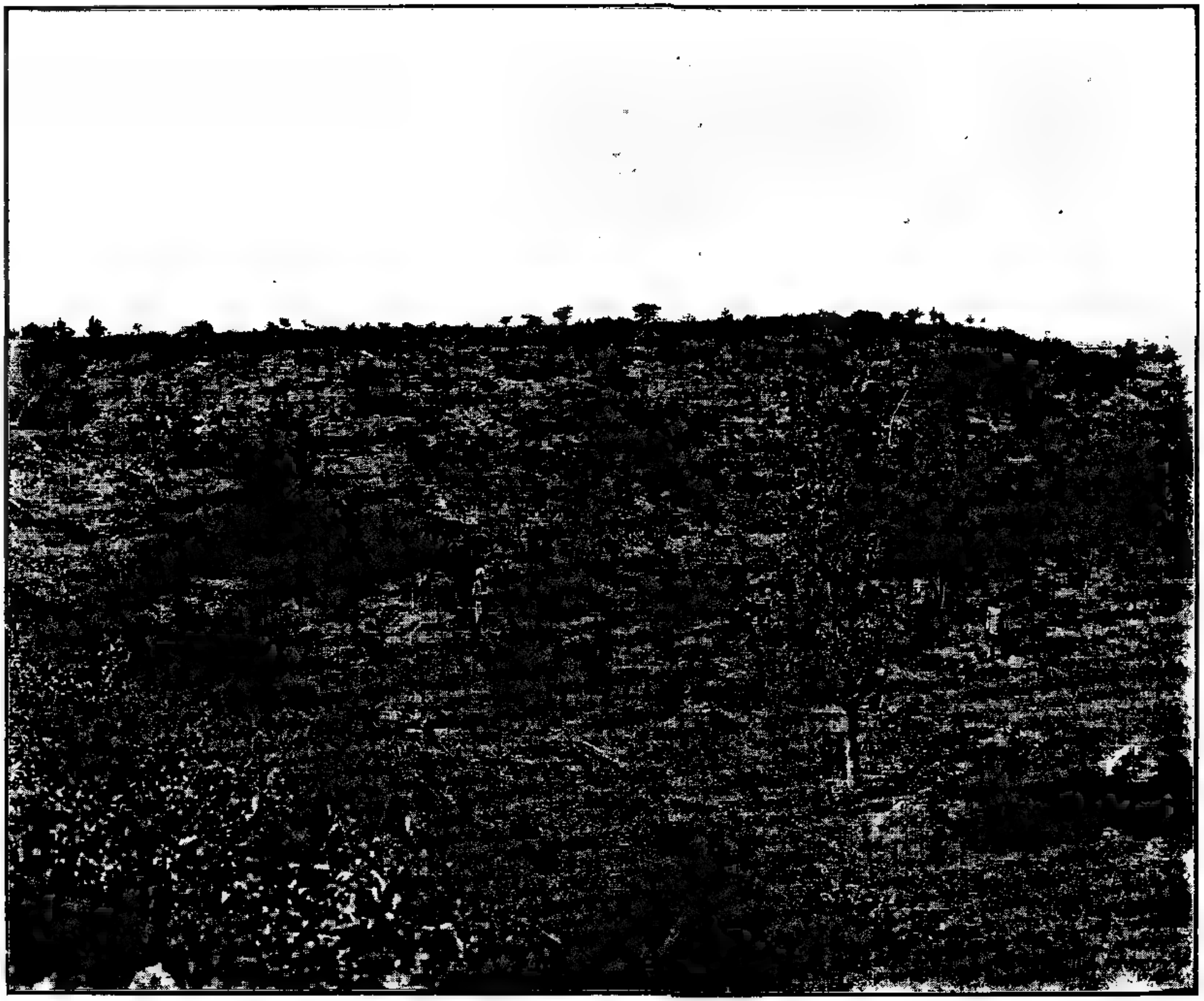
Later on 2- to 3-year-old plants of all the above-named species and root-suckers of Sissu were planted without their stems being cut but with only their foliage and green twigs removed, to minimize loss of moisture from transpiration These also proved successful, but they were watered once a week during the hot weather, as it was risky to trust to the impoverished root-system to make good the moisture lost by transpiration, especially because new foliage appeared in profusion from the dormant buds soon after planting.

During the current year similar planting is being tried without watering and the trial is also being extended to some other species.

Bar (*Ficus bengalensis*) branches have been tried to a considerable extent. When planted in January and February, just before it comes into new leaf, 33 per cent. of the stakes of this species have been found to strike root.

26. In order to get specially quick results, the pits in compartment No. 19 were in 1913 planted up with quick-growing shade trees, which were reared in pots. The trees were watered during the first dry weather. They were Sissu, Nim, Bakain, rain tree, Karanj and Pipal.

27. In addition to the planting and sowing of the tree species as described above, *Dodonea viscosa* seed is sown on the prepared pits, so as to get up shrubby growth against the tree stems. A good deal of custard apple, Kharasi (*Nyctanthes*), Lokhandi (*Ixora*) and Bharati (*Gymnosporia montana*) seeds is dibbled in all over the slopes, with a view to get up shrubs to hide the bare surface in between the prepared trenches and pits. With this object and also to complete the stocking, various kinds of local forest seeds are every year sown broadcast all over the area.



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AFFORESTATION OF SEMINARY HILL, NAGPUR, C. P.

28. *General protection.*—The outside of the whole area and both sides of the road leading to Government House are wire-fenced. This, and the road going from the tiger's gap to the starky point, are the main roads traversing the plantation and are maintained by the Public Works Department.

Maintenance.

The boundaries of compartments and some pathways across them are maintained from plantation funds and serve as efficient inspection paths.

29. *Fire-protection.* The above two main roads are fire-traced. The ground all round the plantation is so heavily grazed that the periphery is not fire-traced. The grass inside the plantation is cut and removed by the Agricultural Department. Hence the cost of fire-protection, which includes the pay of an additional watcher during April to June, is about Rs. 60 per annum.

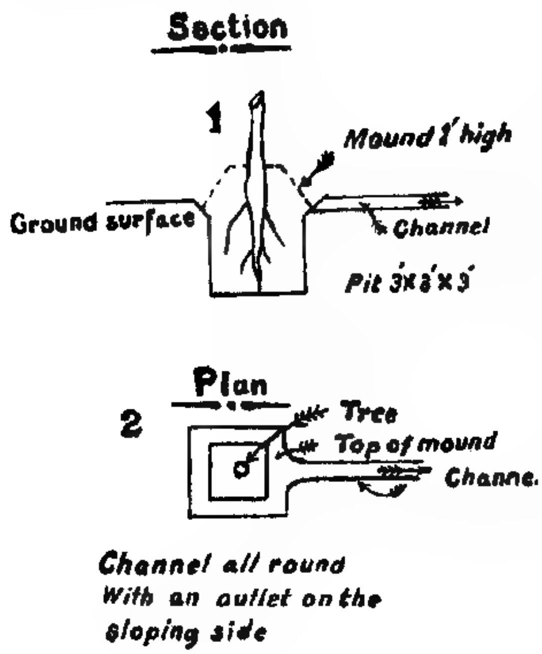
30. *Thinning, pruning and weeding.*—In the original sowings seeds of various species were mixed up and sown in each pit or trench. The seedlings grew up in clusters and it soon became necessary to relieve congestion by retaining the most promising and suitable species. The operation had also to be done gradually year by year, according to the increasing space requirements of the plants. This was taken advantage of in planting up blanks, as well as new pits, as already described, and what was at first considered a drawback was, to a certain extent, turned to good account.

During these thinnings the pruning of lower branches, wherever necessary, is done with a view to help the development of the stems.

From the method of periodically working up the soil now adopted, which is described below, no weeds can exist in the pits or trenches.

31. *Watering.*—Watering is done through bamboo tubes let into each pit. It is sparingly resorted to and chiefly to favour the plants put out in unfavourable places and to help the more delicate species such as the mango, Tun, gold mohar, etc., and the cuttings and transplants, including Bar branches, which cannot be planted during the rains.

Thanks to the care taken of the soil, as described below, much watering is saved. The cost has varied from Rs. 600 to Rs. 1,000 per annum.



32. *Other tending operations.*—Under this head the periodical raking of the soil, so as to keep it loose and free and well-heaped against the stems, (see diagram on margin,) has to be mentioned. This method has promoted the growth of plants to a remarkable degree as can be seen from the following statement :—

Sample plot No.	Compartment No.	Situation, soil, aspect, etc.	When measurements were taken. Month.	Year.	Average height of plants (in feet and inches). *Hardwickia binata.*	*Melia Azadirachta.*	*Pterocarpus Marsupium.*	Teak.	*Dalbergia Sissu.*	*Albizzia odoratissima.*	*Boswellia serrata.*
							Sowings made in 1910.				
1	11	On slope facing east, sheltered against hot winds, soil reddish loam: resulting from well-weathered 'muram.'	February ..	1913	1' 11"	5' 7"	1' 2'	6' 1"	3' 4"	2' 10'	...
			October ..	1914	3' 11"	8' 2'	4' 5'	8' 6'	5' 4"	3' 8"	...
2	9	On slope facing south, very exposed to hot winds, soil same as above. (A).	February..	1913	1' 7"	..	...	..	1' 1"	6' 7"	...
			October ...	1914	3' 1	...	...	...	1' 8"	(b)	...
3	12 & 13	On slope facing south, very exposed, soil yellowish 'muram' not fully weathered (A-1).	February...	1913	0' 9'	...	.	...	...	1 1'	..
			October ..	1914	2' 0"	...	...	...	...	(b)	...
4	13	On slope facing south-east to east, soil same as above, rock very near surface. (A-1).	February	1913	0' 9'	1 11	...	.	1' 0"	0' 4'	...
			October ..	1914	2' 0'	4' 0'	...	...	1' 9"	6' 1"	..
5	15	On slope facing north, rock very near surface in places, soil yellowish 'muram', not fully weathered. (A).	February	1913	0' 5'	0' 6'	...	...	...	0' 9"	
			October ...	1914	1' 6'	(b)	(h) 1' 0'	(h) 1' 4"	...	1' 5"	...
6	16	In all particulars as above. (A).	February...	1913	1' 1"	0' 7'	...	...	...	5' 5"	..
			October ..	1914	3' 7"	(b)	...	...	...	9' 0"	...

Sample plot No.	Compartment No.	Situation, soil, aspect, etc.	When measurements were taken. Month	Year.	Average height of plants (in feet and inches). *Hardwickia binata.*	*Melia Azadirachta.*	*Pterocarpus Marsupium*	Teak.	*Dalbergia Sissu.*	*Albizzia odoratissima.*	*Boswellia serrata.*
7	10	On plateau but very gently sloping southwards, soil black cotton, very shallow, resting on hard pan of 'muram' and boulders (B).	February...	1913	1' 0"	...	...	..	0' 8'	0' 4"	0' 2'
			October .	1914	1' 11'	.	(h) 1' 2"	.	2' 7"	1' 2'	2' 6"
		Total average for all plots ...	February...	1913	1' 1'	2' 2"	1' 2	6' 1	1' 6"	2' 6"	0' 2'
			October .	1914	2' 7'	6' 1'	2' 2'	4' 11'	2' 10'	4' 3'	2' 6"
					Planted in September and October 1913 with seedlings about 15 days to a month old.						
8	18	At foot of hill, gently sloping eastwards, soil silty 'muram.' (C).	June ...	1915	1' 10'	4' 0'	.	...	3 10	.	.
9	18	Ditto, but hard rock appears on the surface in places. (C).	June	1915	1' 8'	3 4'	...		2' 8'	4 10'	...
		Total average for 8 and 9 ...	June ...	1915	1 9	3 8"	...	.	3' 3'	4 10'	.
					Planted in September 1913 with transplants previously reared in pots for one year.						
10	19	Level ground containing silty soil resting on friable 'muram' through which a good deal of water percolates. (D).	June	1915	.	9' 3"	.		13' 10'	...	

Sample plot No.	Compartment No.	Situation, soil, aspect, etc.	When measurements were taken. Month.	Year.	Average height of plants (in feet and inches). *Terminalia Arjuna*	*Dalbergia latifolia.*	*Soymida febrifuga.*	*Bassia latifolia.*	*Ficus religiosa.*	*Pongamia glabra.*	*Melia Azedarach*	*Pithecolobium Saman.*
					Sowings made in 1910.							
1	11	On slope facing east, sheltered against hot winds, soil red dish loam: resulting from well-weathered 'muram.'	February	1913	2' 7'				.	...	...	..
			October	1914	(b)	..		.		..	...	...
2	9	On slope facing south, very exposed to hot winds, soil same as above. (A).	February ..	1913	2' 8		..	..		...	...	...
			October ...	1914	2' 10"					...	...	..
3	12 & 13	On slope facing south, very exposed, soil yellowish 'muram' not fully weathered. (A-1).	February .	1913	...	..	..	..		...	...	...
			October ..	1914		..		...	..	. .	...	
4	13	On slope facing south-east to east, soil same as above, rock very near surface. (A 1).	February...	1913	...	...	...	0 8	..	. .	.	...
			October .	1914	...	...	...	(b)	.	...	..	...
5	15	On slope facing north, rock very near surface in places, soil yellowish 'muram,' not fully weathered. (A).	February .	1913	1' 3'	..	...	..	-	...	..	...
			October ..	1914	3' 7		(h) 0' 9'		..	...	. .	..
6	16	In all particulars as above. (A).	February .	1913	3' 0	0' 6	...	1' 4'	...	1' 1"	...	..
			October ...	1914	4' 2'	2' 1"	.	4' 5'	...	2' 5'	...	..
7	10	On plateau but very gently sloping southwards, soil black cotton very shallow, resting on hard pan of 'muram' and boulders (B).	February...	1913		...	.	..	...	..	...	. .
			October ..	1914	.	..	...		...	..	...	...
		Total average for all plots	February . .	1913	2' 4"	0' 6		1' 0	..	1' 1	. .	
			October	1914	3' 6'	2' 1'	0' 9'	4' 5"		2' 5"	.	.

Sample plot No.	Compartment No.	Situation, soil, aspect, etc.	When measurements were taken. Month	Year	Average height of plants (in feet and inches). Terminalia Arjuna.	Dalbergia latifolia.	Soymida febrifuga.	Bassia latifolia.	Ficus religiosa	Pongamia glabra.	Melia Azadirach	Pithecolobium Saman.
					Planted in September and October 1913 with seedlings about 15 days to a month old.							
8	18	At foot of hill, gently sloping eastwards, soil silty 'muram.' (C).	June ...	1915	.		.	..	(i) 2' 2'	..	.	..
9	18	Ditto, but hard rock appears on the surface in places. (C).	June ...	1915	..		..	..		..	...	...
		Total average for 8 and 9 ...	June .	1915	...	.	...	...	2 2'	..	.	...
					Planted in September 1913 with transplants previously reared in pots for one year.							
10	19	Level ground containing silty soil resting on friable 'muram' through which a good deal of water percolates. (D).	June ...	1915	...	.	...		9' 0'	4' 8"	11' 2"	15' 3"

(b) Died.
(h) Not measured in 1913.
(i) Planted with transplants.
(A)– Sowings made on pits 8' × 2' × 2'. Pits filled up with surface soil all round scraped in.
(A-1) Sowings made on pits 8' × 3' × 2'. Pits filled up with surface soil all round scraped in. Good black soil introduced in 1913 14.
(B)—Sowings made on pits 2' × 2' × 2' with surface soil scraped in.
(C) Planting of about 15 days old seedlings made chiefly on pits 2' × 2' × 2' filled with good soil brought from outside.
(D) Pot-reared, plants planted on 3' × 3' × 3', pits filled with good soil. Compartment drained to take off percolation water. Plants atered during December 1913 to June 1914.

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AFFORESTATION OF SEMINARY HILL, NAGPUR, C. P.

In the first seven sample plots the measurements were taken in February 1913 when this mode of cultivating the soil was not resorted to and also in October 1914, when their cultivation was going on for one growing season. The figures for sample plots 8 to 10 represent areas tended in this manner from the very outset.

This method is the practical application to arboriculture of what is called "dry cultivation," so much spoken of in recent years. It reduces the injurious effects of waterlogging in the rains by inducing the free circulation of air in the soil, and in the dry weather it serves to check evaporation, the moisture that rises by capillarity to the surface, from the lower layers, being unable to reach the surface owing to the medium being broken, it thus becomes available for the roots of the plants.

33. Officers of the Imperial Forest Service who have done a part of their practical training in the plains below the *olden waldes* in the grand Duchy of Hesse could recall to mind that the successful raising of new crops of oak and Scotch pine is largely due to the thorough and deep cultivation of the soil, which in that plain is dry and poor, and varies from fine-grained dune sand to coarse gravel, resting on a stratum of tertiary clay some 14 to 18 meters below the surface of the ground. The exploited areas, the fellings made being clear fellings, are first ploughed up with a surface plough and then deepened with a deep-going plough or grubber. Oak sowings or pine plantings are made in furrows one meter apart and these intervals are worked with the grubber for two or three years.

Some observers say that this method tends to keep the roots near the surface and consequently is harmful to the trees. Perhaps this may be the case where the soil is merely heaped up against the stem and then left undisturbed, but in the Telankheri Hill plantation the ground for a radius of one foot to two feet from the stems is loosened to a depth of several inches every time the heap of earth above ground is raked up.

It is probable that when the roots outgrow the feeding capacity of the good soil put into the pit, they may meet with some

check, but the strength and vigour now put into the plants by this tending would increase the chances of their roots working down into the fissures in the rock.

The cost of this method of tending is roughly Rs. 1,000 per annum.

Establishment.

34 A Forester on Rs. 18 is in charge of the plantation. He is assisted by a guard on Rs. 12 and two watchers on Rs. 8 each. The annual cost in round figures is Rs. 600.

Summary of expenditure.

35. The expenditure incurred from the beginning may be classified as under :

		Rs.	Rs
(i) Improvement and preparation of the soil.	Construction of dams, waste weirs, etc.	5,100	
	Direct preparation of the soil, digging and filling of pits and trenches, including cost of black soil, ploughing, etc.	17,647	
	Cost of tools and repairs ..	1,776	
			24,523
(ii) Sowing and planting .	Sowing and planting, cost of collection of seed, maintenance of nurseries, etc.	..	2,882
(iii) Tending	Watering, weeding and other tending, including cost of fixing bamboo tubes seasonally for watering.	...	8,124
(iv) Protection .. .	Fencing, including cost of gates, repairs, etc.	6,629	
	Roads and paths ..	162	
	New buildings and repairs .	3,259	
	Fire-protection	315	
	Establishment	6,080	
			16 445
(v) Miscellaneous ...	...	...	474
	Total	...	52,448

36. The situation of the area in the middle of a station and the adverse factors of the locality are responsible for this high cost. The following details under the cost of direct preparation of the

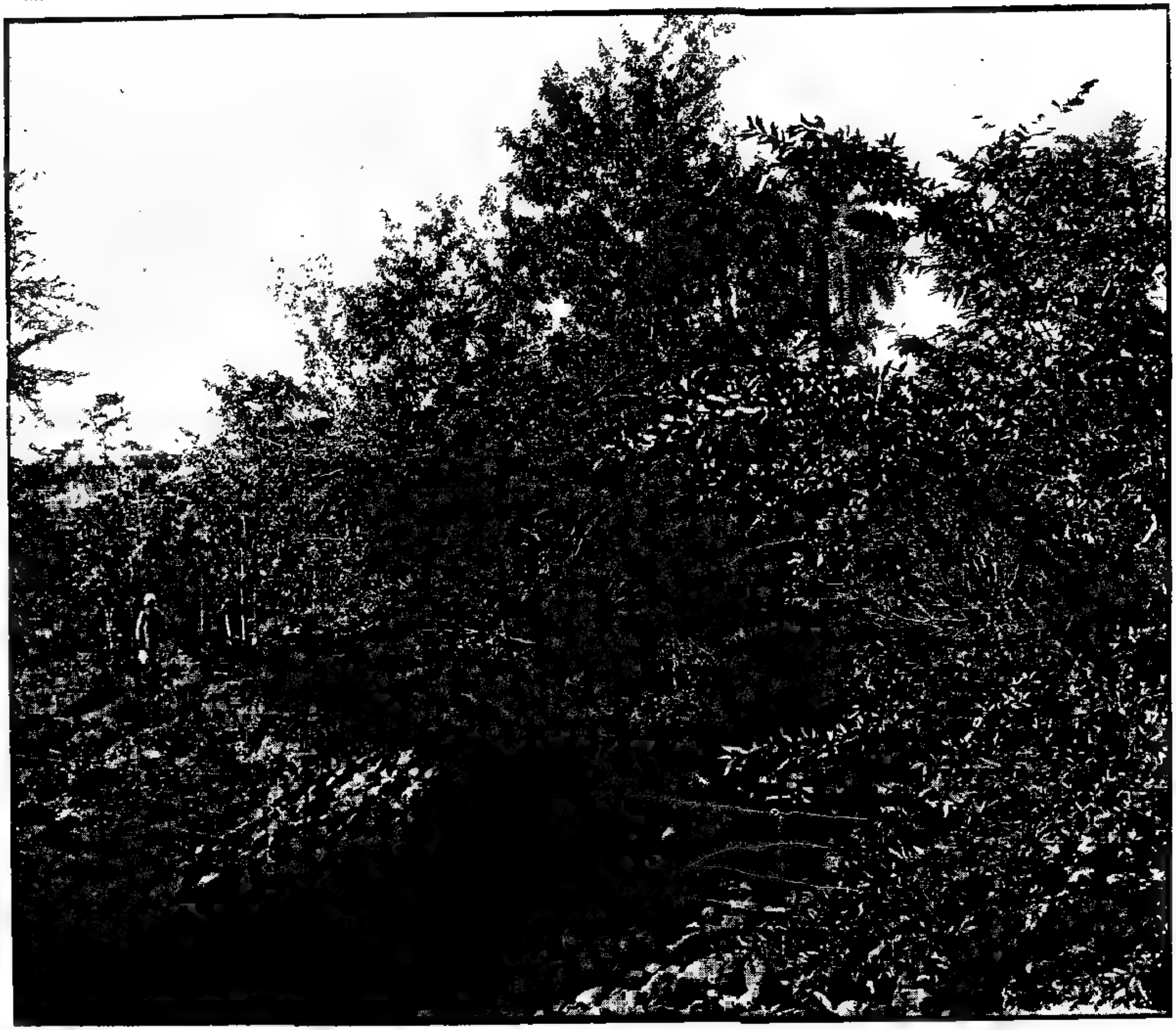


Photo. engraved & printed at the Photo.-Mech. & Litho. Dept., Thomason College, Roorkee.

AFFORESTATION OF SEMINARY HILL, NAGPUR, C. P.

soil indicate the extraordinarily unfavourable conditions of soil and sub-soil that had to be contended with :—

Digging and refilling	1,393	trenches	9′ × 3′ × 3′ @ Rs. 2-4	each,	cost	Rs.	3,134
Ditto	4,649	,,	8′ × 2′ × 2′ @ Re. 1 4 to 1-8	,,	,,	,,	6,193
Ditto	451	pits	5′ × 5′ × 5′ @ Rs. 2-8	,,	,,	,,	1,015
Ditto	126	,,	4′ × 4′ × 4′ @ Re. 1-8	,,	,,	,,	189
Ditto	770	,,	3′ × 3′ × 3′ @ Re. 0-7 to 1-0	,,	,,	,,	475
Ditto	34,019	,,	2′ × 2′ × 2′ @ Re. 0-2 to 0-3	,,	,,	,,	4,317
Ditto	1,456	,,	1′ × 1′ × 1′ @ Re. 0-0-6	,,	,,	,,	45
Making 105 maunds of black soil @ Re. 1-4				,,	,,	,,	131
Ploughing and hoeing strips				...	,,	,,	1,023
Raking and refilling 20,000 2′ cube pits, to correct subsidence, at Re. 0-0-9 each						...	1,125
				Total		..	17,647

37. The work of systematic renewal of failures and filling up of blanks will be completed during the current year, at the end of which the total cost is estimated to amount to Rs. 55,000 or Rs. 277 per acre. In future years only replacement of casualties, a little tending and maintenance have to be provided for, the annual cost of which will not exceed Rs. 2,000, but will diminish every year till in another 4 or 5 years it is expected to be about Rs. 1,000, which is a reasonable annual charge for the maintenance of a wood for the benefit of a large station.

Future promise.

38. Plates 39 to 42 represent the present condition of the plantation in the places which were photographed six years ago. The original photographs were printed in the issue of the *Indian Forester* for January and February 1910. Owing to the growth of the plants in the nearest rows the camera had to be slightly shifted from the points from which the original photographs were taken, but the objectives are the same. The photographs numbered 38, 39, 40, 41 correspond respectively with the originals numbered 1, 2, 3, 4.

There are at present 53,838 fully established plants growing in the plantation which gives a stocking of 272 stems per acre. Whilst the present condition is more than an assurance of the success of the plantation, the stocking is sufficient for the natural increase and survival of the wood.

39. Though the value of fodder grass, which the area is capable of yielding for the Agricultural Department while the trees are growing up, is not less than Rs. 2,000 per annum and most of the trees grown are also valued for their timber, particularly in a place like Nagpur, the financial aspect of the scheme is not discussed. The undertaking could not have attained even a fraction of the success, which it has attained, if it had been conducted only on commercial principles. It is also impossible to set down in terms of rupees, annas and pies, the hygienic and æsthetic value of the plantation.

THE USES OF FORMOSAN TREES.

BY R. KANEHIRA, GOVERNMENT FORESTER OF FORMOSA (JAPAN).

The Island of Formosa lies between 25° 30′ and 21° 40′ north latitude and 119° and 122° 10′ east longitude. It possesses an area of 13,890 square miles—nearly half that of Ceylon. The area of forest is estimated at 5,000,000 acres which is about 55 per cent. of the total area of the Island. About two-thirds of the forest area is inhabited by wild peoples. Topographically the Island may be divided into two parts, the mountain district and the plains district. The former is occupied by the central range of mountains which is almost entirely of paleozoic formation.

This range extends from north to south, the highest peaks being often more than 12,000 feet in altitude and almost entirely covered by perennial verdure. In these mountains are located the so-called savage districts. The plains district lies mostly west of the mountains and is of alluvial formation, irrigated by many rivers and streams, and comprises the most fertile and productive parts of the Island.

Since the Island is located between the tropical and subtropical zones and possesses very many high mountains, the climate is very varied, and the flora of trees and shrubs very rich. Formosa possesses some 3,325 species of plants, of which 600—700 are woody plants.

Of forest types represented in the Island, we may distinguish three, excluding of course the plains district and the summit grass lands, since the former is largely cultivated and the latter largely open meadows. These types are (1) ever-green broad-leaved forests, of some 3,000,000 acres; (2) mixed stands of broad-leaved trees and conifers, of some 400,000 acres; (3) and finally, pure coniferous forests of some 670,000 acres. In economic value, the coniferous forests easily come first, in spite of their smaller area, since they produce large, straight and very useful timbers. The Formosan trees of highest economic value fall into three of the natural families of plants: (1) Coniferæ; (2) Cupuliferæ; (3) Lauraceæ. The Lauraceæ includes more than 50 species, the Cupuliferæ about 46 species, while the Coniferæ possesses only 24 species, though these fall into 14 genera. Examining into the geographical distribution of the 600 or so species of woody plants of Formosa, we get the following interesting results:—

Endemic	36 %
Chinese	23 %
Indo-Malayan	22 %
Japanese	19 %

From this it appears that the Indo-Malayan element is very strongly represented in Formosa.

Notwithstanding the existence in Formosa of very rich and extensive forest, only an exceedingly small part of the entire area has been subjected to any form of forest utilisation, with the single exception of camphor manufacture. This is due not only to the fact that a large part of these forests is inhabited by savage people, but also because the whole region is very difficult of access on account of the steepness of the mountain sides. In one sense these conditions are fortunate, since if the forests had not been inhabited by refractory savages, they would probably have been largely destroyed under the Chinese régime.

Before the Island was ceded to Japan some 20 years ago, the only forest product was camphor. The production of camphor continues down to the present day, yielding one of the principal exports of Formosa.

In olden days building materials (mostly *Cunninghamia sinensis*) were imported from China, and ever since passing under Japanese control, the Island has been supplied with such materials by both China and Japan, that from the latter country consisting largely of *Cryptomeria japonica*.

The Formosan Government has now established a Forestry Bureau and begun the systematic exploitation of the forests of the Island, so that ere long Formosa will be in a position to export, instead of importing, timber.

The Formosan Government does not intend to limit its attention solely to the exploitation of the existing forests. Reproduction and reforestation will receive al, necessary attention. The most valuable forest trees of all countries, which may be suited to our conditions, will be introduced here and propagated. Even now more or less extensive plantations are being made of such trees as *Dalbergia Sissoo*, *Albizza Lebbek*, *Pterocarpus* spp., *Tectona grandis*, etc. At this time attention may be called to our very earnest desire to exchange seeds and seedlings of many of our most interesting and important trees, for those of other countries with similar conditions. In this matter, the writer places himself at the service of the Forestry Bureau of other countries.

According to their uses, Formosan trees may be classified as follows :—

I. TIMBER.

(1) *Building Timbers.*

Even at the present time we still use for building quantities of *Cunninghamia sinensis* and *Cryptomeria japonica* imported from China and Japan. However there are many important native species which can be used for these purposes as indicated by the following table :—

Albizzia procera, *Benth.*	Chamæcyparis formosensis, *Mats.*
Areca Catechu, *L.*	,, obtusa, *S.* et *Z.*, forma formosana, *Hay.*
Bambusa stenostachya, *Hack.*	
Bischofia javanica, *Bl.*	Cinnamomum Camphora, *Nees* et *Ebe.*
Calophyllum Inophyllum, *L.*	,, reticulatum, *Hay.*
Capparis formosana *Hemsl.*	Cordia Myxa, *L.*

Cryptocarya chinensis, *Hemsl.*
Dendrocalamus latiflorus, *Munro.*
Ehretia acuminata, *R. Br.*
Eugenia formosana, *Hay.*
,, Kashotoensis, *Hay.*
Evodia meliæfolia, *Benth.*
Gordonia anomala, *Spreng.*
Keteleeria Davidiana, *Beiss.*
,, var. formosana, *Hay.*
Lagerstrœmia subcostata, *Koehne*
Liquidambar formosana, *Hance*
Macaranga Tanarius, *Muell. Arg.*
Machilus formosana, *Hay*
,, Kusanoi, *Hay.*
,, Thunbergii, *S.* et *Z.*
Mangifera indica, *L.*
Melia Azedarach, *L.*
Michelia Compressa, *Sarg.*
Nauclea truncata, *Hay.*
Palaquium formosana, *Hay.*
Pinus Armandii, *Franch.*
,, formosana, *Hay.*
,, Massoniana, *Lamb*
,, taiwanensis, *Hay.*
Podocarpus Nageia, *R. Br.*
Pometia pinnata, *Forst.*
Premna integrifolia, *L.*
Quercus glauca, *Thunb.*
,, ternaticupula, *Hay.*
,, uraiana, *Hay.*
Sideroxylon ferrugineum, *H.* et *A*
Stereospermum sinicum, *Hance.*
Taiwania cryptomerioides, *Hay.*
Thea shinkoensis, *Hay.*
Trema orientalis, *Bl.*
Vitex heterophylla, *Roxb*

(2) *Miscellaneous industrial implements.*

A great variety of native implements are made from Formosan woods. For these purposes the following species are commonly employed:—

Bambusa stenostachya, *Hack.*
Bauhinia Championi, *Benth.*
Bischofia javanica, *Bl.*
Buxus sempervirens, *L.*
Calophyllum Inophyllum, *L.*
Capparis formosana, *Hemsl.*
Celtis formosana, *Hay.*
Chamæcyparis formosensis, *Mats.*
,, obtusa, *S.* et *Z.* forma formosana, *Hay.*
Champereia Cumingiana, *Merrill.*
Cinnamomum Camphora, *Nees* et *Ebe.*
Diospyros discolor, *Willd.*
Diplospora viridiflora, *DC*
Erythrina indica, *Lam.*
Ficus insularis, *Miq.*
,, nervosa, *Heyne.*
Geronium aequoreum, *Hance.*
Gleditschia formosana, *Hay.*
Helicia formosana, *Hemsl.*
Heptapleurum octophyllum, *Benth.*
Lagerstrœmia subcostata, *Koehne.*
Libocedrus macrolepis, *Benth.*
Liquidambar formosana, *Hance.*
Maba buxifolia, *Pers.*
Machilus Kusanoi, *Hay.*
,, longifolia, *Bl.*
Mangifera indica, *L.*
Melia Azedarach, *L.*
Michelia Compressa, *Sarg.*
Murraya exotica, *L.*
Myrica rubra, *S.* et *Z.*
Nauclea truncata, *Hay.*
Nephelium Longana, *Camb.*
Paulownia Mikado, *Ito.*
Photinia deflexa, *Hemsl.*
Phyllostachys mitis, *Riv.*
Pistacia formosana, *Mats*
Podocarpus Nageia, *R. Br.*
Premna integrifolia, *L.*
Psidium Guyava, *L.*
Quercus cuspidata, *Thunb.*

Quercus glauca, *Thunb.*
,, pseudomyrsinæfolia, *Hay.*
,, ternaticupula, *Hay.*
Sapium sebiferum, *Roxb.*
Terminalia Catappa, *L.*
Trema orientalis, *Bl.*
Wendlandia paniculata, *DC.*
Zelkova acuminata, *Plance*

(3) *Agricultural implements and tools.*

Acacia confusa, *Merrill.*
Acronychia laurifolia, *Bl.*
Actinodaphne pedicellata, *Hay.*
Aglaia formosana, *Hay*
Albizzia procera, *Benth.*
Bambusa stenostachya, *Hack.*
Clausena lunulata, *Hay.*
Cleyera ochnacea, *Bl.*
Cinnamomum Camphora, *Nees* et *Ebe.*
Diospyros eriantha, *Champ.*
Engelhardtia spicata, *Bl.*
var. formosana, *Hay.*
Eugenia formosana *Hay.*
Fraxinus formosana, *Hay.*
Gardenia florida, *L.*
Glochidion album, *Muell. Arg.*
Heptapleurum octophyllum, *Benth*
Lagerstrœmia subcostata, *Koehne*
Michelia Compressa, *Sarg.*
Phyllostachys mitis, *Riv.*
Quercus gilva, *Bl.*
,, glauca, *Thunb.*
,, pseudomyrsinæfolia, *Hay.*
Scolopia crenata, *Clos.*
Sideroxylon ferrugineum, *H.* et *A.*
Trema orientalis, *Bl.*

(4) *Furniture.*

Acacia confusa, *Merrill*
Bischofia javanica, *Bl.*
Dendrocalamus latiflorus, *Munro.*
Evodia meliæfolia, *Benth.*
Fraxinus formosana, *Hay.*
Kleinhovia Hospita, *L.*
Libocedrus macrolepis, *Benth.*
Machilus Kusanoi, *Hay.*
Melia Azedarach, *L.*
Michelia Compressa, *Sarg.*
Nephelium Longana, *Camb.*
Palaquium formosana, *Hay.*
Paulownia Kawakamii, *Ito.*
Podocarpus Nageia, *R. Br.*
Thea shinkoensis, *Hay.*

(5) *Various wheeled vehicles.*

Acacia confusa, *Merrill.*
Chamæcyparis formosensis, *Mats.*
Gleditschia formosana, *Hay.*
Machilus Kusanoi, *Hay.*
Michelia Compressa, *Sarg.*
Nephelium Longana, *Camb.*
Quercus glauca, *Thunb.*
,, pseudomyrsinæfolia, *Hay.*
Semma Noronhæ, *Reinw.*
Terminalia Catappa, *L.*
Ulmus parvifolia, *Jacq*
Zelkova acuminata, *Plance.*

(6) *Boats, rafts and their equipments.*

Acacia confusa, *Merrill.*
Bambusa stenostachya, *Hack.*
Celtis sinensis, *Pers.*
Cinnamomum Camphora, *Nees* et *Ebe.*
Dendrocalamus latiflorus, *Munro.*
Liquidambar formosana, *Hance.*
Nauclea truncata, *Hay.*
Nephelium Longana, *Camb.*
Pisonia excelsa, *Bl.*
Pistacia formosana, *Mats.*
Pometia pinnata, *Forst.*
Quercus gilva, *Bl.*
,, glauca, *Thunb.*
Terminalia Catappa, *L.*
Zelkova acuminata, *Plance.*

(7) *Boxes.*

Alniphyllum pterospermum, *Mats.*
Alnus formosana, *Makino.*
Heptapleurum octophyllum, *Benth.*
Pinus Massoniana, *Lamb.*
Sapium discolor, *Muell. Arg.*

(8) *Turnery.*

Bauhinia Championi, *Benth.*
Heptapleurum octophyllum, *Benth.*
Lagerstrœmia subcostata, *Koehne.*

(9) *Bridges.*

Chamaecyparis formosensis, *Mats.*
,, obtusa, *S.* et *Z.*, forma formosana, *Hay.*
Machilus Kusanoi, *Hay.*
Pinus formosana, *Hay.*

(10) *Pegs or Poles.*

Pinus Massoniana, *Lamb.*

(11) *Railway sleepers.*

Pinus Massoniana, *Lamb.*

(12) *Coffins.*

Natives are commonly addicted to the use of *Cunninghamia sinensis* for coffins but the following native woods are also used :

Chamaecyparis formosensis, *Mats.*
,, obtusa, *S.* et *Z.* forma formosana, *Hay.*
Cunninghamia Konishii, *Hay.*
Hibiscus tiliaceus, *L.*
Keteleeria Davidiana, *Beiss.* var. formosana, *Hay.*
Podocarpus Nageia, *R. Br.*
Trema orientalis, *Bl.*

(13) *Ornamental woods.*

Acacia confusa, *Merrill*
Bischofia javanica, *Bl.*
Cinnamomum Camphora, *Nees* et *Ebe.*
Diospyros discolor, *Willd.*
Helicia formosana, *Hemsl.*
Libocedrus macrolepis, *Benth.*
Maba buxifolia, *Pers.*
Nephelium Longana, *Camb.*
Pistacia formosana, *Mats.*

(14) *Stock for Carvings.*

Bischofia javanica, *Bl.*
Buxus sempervirens, *L.*
Capparis Henryi, *Mats*
Champereia Cumingiana, *Merrill.*
Cinnamomum Camphora, *Nees* et *Ebe.*
Diplospora viridiflora, *DC.*
Gardenia florida, *L.*
Libocedrus macrolepis, *Benth.*
Machilus Kusanoi, *Hay.*
Murraya exotica, *L.*
Podocarpus Nageia, *R. Br.*
Psidium Guyava, *L.*
Pyrus sinensis, *Lindl*

(15) *Sheaths and Scabbards.*

Ehretia acuminata, *R. Br.*
Heptapleurum octophyllum, *Benth.*
Kleinhovia Hospita, *L*
Mallotus moluccanus, *Muell. Arg.*
Rhus semialata, *Murr.*
Zanthoxylum ailanthoides, *S.* et *Z.*

(16) *Barrels or Tubs.*

Chamæcyparis formosensis, *Mats.*
Cinnamomum Camphora, *Nees* et *Ebe.*
,, micranthum, *Hay.*
Ficus insularis, *Miq.*
Heptapleurum octophyllum, *Benth.*
Machilus Kusanoi, *Hay.*
Sapium discolor, *Muell.*
Zanthoxylum ailanthoides, *S.* et *Z.*

(17) *Walking-sticks.*

Ardisia crenata, *Roxb.*
Areca Catechu, *L.*
Cudrania javanensis, *Trec.*
Derris laxiflora, *Benth.*
Diospyros discolor, *Willd.*
Euonymus pellucidifolia, *Hay.*
Lagerstrœmia subcostata, *Koehne.*
Maba buxifolia, *Pers.*
Murraya exotica, *L.*
Nephelium Longana, *Camb.*
Pemphis acidula, *Forst.*
Pistacia formosana, *Mats.*

(18) *Toys.*

Buxus sempervirens, *L.*
Cudrania javanensis, *Trec.*
Excæcaria Agallocha, *L.*
Liquidambar formosana, *Hance.*
Myrica rubra, *S.* et *Z.*
Paliurus ramosissimus, *Poir*

(19) *Buoys.*

Excæcaria Agallocha, *L.*
Ficus Wightiana, *Wall.*
Heptapleurum octophyllum, *Benth.*
Hibiscus tiliaceus, *L.*
Kleinhovia Hospita, *L.*
Mallotus moluccanus, *Muell. Arg.*

(20) *Musical instruments.*

Areca Catechu, *L.*
Bambusa stenostachya, *Hack.*
Bischofia javanica, *Bl.*
Buxus sempervirens, *L.*
Cinnamomum Camphora, *Nees* et *Ebe.*
Cordia Myxa, *L.*
Melia Azedarach, *L.*
Michelia Compressa, *Sarg.*
Pandanus odoratissimus, *L.*
Phyllostachys bambusoides, *S.* et *Z.*
Sterculia platanifolia, *L.*
Trema orientalis, *Bl.*

(21) *Models.*

Under this head are included models for use in the manufacturing of native hats, shoes, etc.

Acacia confusa, *Merrill.*
Cratæva religiosa, *Forst.*
Melia Azedarach, *L.*
Sapium sebiferum, *Roxb.*

(22) *Clogs.*

Canarium album, *Rauesch.*
Cordia Myxa, *L.*
Ficus Wightiana, *Wall.*
Heptapleurum octophyllum *Benth.*
Hernandia peltata, *Meissn*
Mallotus cochinchinensis, *Lour.*
Paulownia Mikado, *Ito.*
Sapium sebiferum, *Roxb.*
Stereospermum sinicum, *Hance*
Trema orientalis, *Bl*

(23) *Chop-sticks.*

Bambusa stenostachya, *Hack.*
Diospyrus Lotus, *L.*
Euonymus pellucidifolia, *Hay.*
Nephelium Litchi, *Camb.*
Phyllostachys mitis, *Riv.*

(24) *Charcoal and Firewoods.*

Most of the Formosan woods can be used for fuel but those most largely employed are *Acacia confusa* and *Nephelium Longana*. Others are as follows:—

Alniphyllum pterospermum, *Mats*
Alnus formosana, *Makino*.
Decaspermum paniculatum, *Kurz*.
Dodonea viscosa, *L.*
Erythrophleum Fordii, *Oliv.*
Lagerstrœmia subcostata, *Koehne*.
Leucæna glauca, *Benth*
Mangifera indica, *L.*
Photinia deflexa, *Hemsl.*
,, taiwanensis, *Hay*
Psidium Guyava, *L.*
Rhus semialata, *Murr*
Styrax formosana, *Mats*
,, suberifolium, *H.* et *A.*
Symplocos spicata, *Roxb.*

(25) *Smoking pipes.*

Atlantia buxifolia, *Oliv.*
Bambusa stenostachya, *Hack.*
Capparis Henryi, *Mats.*
Capsicum minimum, *Roxb.*
Cudrania javanensis, *Trec.*
Dendrocalamus latiflorus, *Munro.*
Diospyros Lotus, *L.*
Euonymus pellucidifolia, *Hay.*
Lycium chinense, *Mill.*
Pandanus odoratissimus, *L.*
Phyllostachys nigra, *Munro.*

II. SUPPLEMENTARY USEFUL PRODUCTS OF FORMOSAN TREES.

(1) *Edible fruits and other food products.*

Anona reticulata, *L.*
,, squamosa, *L.*
Averrhoa Carambola, *L.*
Cajanus indicus, *Spr.*
Carica Papaya, *L.*
Citrus Medica, *L.*
Cordia Myxa, *L.*
Cudrania javanensis, *Trec.*
Dendrocalamus latiflorus, *Munro.*
Diospyros discolor, *Willd.*
,, Kaki, *L.*
,, Kusanoi, *Hay.*
Eugenia Jambos, *L.*
,, javanica, *Lamk.*
Ficus Aukeotsang, *Makino.*
Juglans formosana, *Hay.*
Mangifera indica, *L.*
Myrica rubra, *S.* et *Z.*
Nephelium Litchi, *Camb.*
,, Longana, *Camb.*
Palaquium formosana, *Hay.*
,, polyandrum, *Hay.*
Photinia deflexa, *Hemsl.*
Phyllostachys bambusoides, *S.* et *Z.*
Pometia pinnata, *Forst.*
Prunus Mume, *S.* et *Z.*
,, persica, *S.* et *Z.*
Psidium Guyava, *L.*
Pyrus formosana, *Kawakami* et *Koidz.*
,, sinensis, *Lind.*
Rhodomyrtus tomentosa, *Wight.*
Sageretia theezans, *Brongne.*
Sterculia nobilis, *R. Br.*
Vaccinium bracteatum, *Thunb.*
Zizyphus Jujuba, *Lam.*

(2) *Beverage.*

Abrus precatorius, *L.*
Cinnamomum nominale, *Hay.*
Citrus Medica, *L.*
Ehretia buxifolia, *Roxb*
Psidium Guyava, *L.*
Thea chinensis, *Sims.*
Vitex trifolia *L. f*

(3) *Masticatories.*

Areca Catechu, *L.*
Cinnamomum nominale, *Hay.*
Ficus retusa, *L.*
Piper Betle, *L.*

(4) *Medicaments and Poisons.*

Abrus precatorius, *L.*
Alocasia cucullata, *Schott.*
Aloe chinensis, *Baker.*
Areca Catechu, *L.*
Asarum macaranthum, *Hook.*
Atlantia buxifolia, *Oliv.*
Berberis nepalensis, *Spr.*
Blumea balsamifera, *DC.*
Canarium album, *Raeusch.*
Carica Papaya, *L.*
Cerbera Odollam, *Gaertn.*
Clerodendron inerme, *Gaertn.*
,, paniculatum, *L.*
Coriaria intermedia, *Mats.*
Cratæva religiosa, *Forst.*
Croton Tiglium, *L.*
Datura alba, *Nees.*
Desmodium pulchellum, *Benth.*
Ehretia buxifolia, *Roxb.*
Euphorbia antiquorum, *L.*
,, Tirucalli, *L.*
Evodia Roxburghiana, *Benth.*
Fatsia papyrifera, *Vent.*
Ficus retusa, *L.*
Hibiscus mutabilis, *L.*
Illicium anisatum, *L.*
Jatropha Curcas, *L.*
Leonurus sibiricus, *S.*
Lysimachia simulans, *Hemsl.*
Mallotus japonica, *Muell. Arg.*
,, philippinensis, *Muell. Arg.*
Melia Azedarach, *L.*
Myoporum bontioides, *A. Gray.*
Nerium odorum, *Soland.*
Paris lancifolia, *Hay.*
Plumbago zeylanica, *L.*
Podophyllum pleianthum, *Hance.*
Portulaca oleracea, *L.*
Randia dumetorum, *Lam.*
Scævola Kœnigii, *Vahl.*
Tabernæmontana coronaria, *Willd.*
Thevetia Nereifolia, *Juss.*
Vitex Negundo, *L.*
,, trifolia, *L.*
Zizyphus Jujuba, *Lam.*

(5) *Fibres.*

Alpinia spp.
Artocarpus incisa, *L. f.*
Boehmeria densiflora, *H.* et *A.*
Bombax malabaricum, *DC.*
Broussonetia papyrifera, *Vent.*
Cordia Myxa, *L.*
Didymosperma Engleri, *Warb.*
Ficus retusa, *L.*
Hibiscus mutabilis, *L.*
,, tiliaceus, *L.*
Kleinhovia Hospita, *L.*
Morus alba, *L.*
Musa textilis, *Nees.*
var. Tashiroi, *Hay.*
Pandanus odoratissimus, *L.*
Sterculia platanifolia, *L.*
Thespesia populnea, *Corr.*
Trachycarpus excelsa, *H. Wendel.*
Trema orientalis, *Bl.*
Villebrunea frutescens, *Bl.*
Wikstrœmia spp.

(6) *Oils.*

Aleurites cordata, *Steud.*
Bombax malabaricum, *DC.*
Caesalpinia Bonducella, *Fleming.*
Calophyllum Inophyllum, *L.*
Chamæcyparis obtusa, *S.* et *Z.*
Cinnamomum Kanehirai, *Hay.*

Cinnamomum pedunculatum, *Nees.*
Jatropha Curcas, *L.*
Ricinus communis, *L.*
Sapium sebiferum, *Roxb*
Thea biflora, *Hay.*

(7) *Waxes*

Rhus semialata, *Murr.*
,, succedanea, *L.*
Sapium sebiferum, *Roxb.*

(8) *Resins.*

Ecdysanthera utilis, *Hay* et *Kaw.*
Euphorbia Tirucalli, *L.*
Semecarpus vernicifera, *Hay* et *Kaw.*

(9) *Lime.*

Cordia Myxa, *L*
Ilex formosana, *Max.*
Trochodendron ralioides, *S.* et *Z.*

(10) *Tannins and Dyes.*

Acacia confusa, *Merrill.*
Areca Catechu, *L.*
Bixa Orellana, *L.*
Cratæva religiosa, *Forst.*
Cudrania javanensis, *Trec.*
Curcuma longana, *L.*
Dioscorea rhipogonoides, *Oliv.*
Elæocarpus decipiens, *Hemsl*
Eurya japonica, *Thunb*
Heritiera littoralis, *Dryand.*
Illicium anisatum, *L.*
Lagerstrœmia subcostata, *Koehne.*
Maesa procumbens, *Hemsl.*
Mallotus philippinensis, *Muell. Arg.*
Myrica rubra, *S.* et *Z.*
Palaquium polyandrum, *Hay.*
Pithecolobium dulce, *Benth.*
Rhamnus formosana, *Mats*
Sapium sebiferum, *Roxb.*
Schima Noronhæ, *Reinw.*
Strobilanthes flaccidifolius, *Nees.*
Ternstrœmia japonica, *Thunb.*

(11) *Fish Poisons and Narcotics.*

Albizzia procera, *Benth.*
Derris taiwanensis, *Hay.*
Schima Noronhæ, *Reinw.*

(12) *Cattle food.*

Broussonetia papyrifera, *Vent.*
Cajanus indicus, *Spr.*
Macaranga Tanarius, *Muell. Arg.*
Meliosma rhoifolia, *Max*
Psidium Guyava, *L.*

(13) *Perfumes.*

Aglaia odorata, *Lour.*

(14) *Flavouring materials for tea.*

Aglaia odorata, *Lour.*
Gardenia florida, *L.*
Jasminum odoratissimum, *L.*
Jasminum Sambac, *Ait.*
Michelia fuscata, *Bl.*
,, longifolia, *Bl.*

(15) *Camphor and Camphor oil.*

Cinnamomum Camphora, *Nees* et *Ebe*
Cinnamomum nominale, *Hay.*

(16) *Joss-sticks.*

Libocedrus macrolepis, *Benth.*
Machilus longipaniculata, *Hay.*
Mallotus japonica, *Muell. Arg.*

(17) *Washing.*

Entada scandens, *Benth.*
Randia dumetorum, *Lam.*
Sapindus Mukorossi, *Gaertn.*
Trichosanthes multiloba, *Miq.*

(18) *Ornamental seeds.*

Abrus precatorius, *L.*
Prunus persica, *S.*
Sapindus Mukorossi, *Gaertn.*
Trachycarpus excelsus, *H. Wendl.*

(19) *Pith paper.*

Pitsia papyrifera, *Vent.*

(20) *Cork.*

Quercus variabilis, *Bl.*

(21) *Brooms*

Decaspermum paniculatum, *Lindl.*
Phœnix Hanceana, *Naudin.*
Trachycarpus excelsus, *H. Wendl.*

(22) *Hats.*

Pandanus odoratissimus, *L.*

BOMBAY FOREST CONFERENCE—COMPLETE VOLUME ANALYSIS OF TEAK FROM KIRWATTI JUNGLES.

BY W. A. MILLER, DIVISIONAL FOREST OFFICER, WORKING PLANS, S. C., BOMBAY.

1. At the last Conference it was mentioned that so far as was known no complete stem-analysis of teak had been made. I therefore thought that the experiments made this season in connection with the revision of the Working Plan for the jungles near Kirwatti would be of interest.

2. The jungles lie on the eastern border of the Eastern Division, Kanara, near the Dharwar Pole Forests and were originally included as high forest in the Yellapur Above-Ghat Plan.

3. The jungles, however, seem in quality to be somewhere between the high forest to the west and the pole area to the east and are not quite suitable for working as high forest.

Fig. 1.

HEIGHT CURVE.

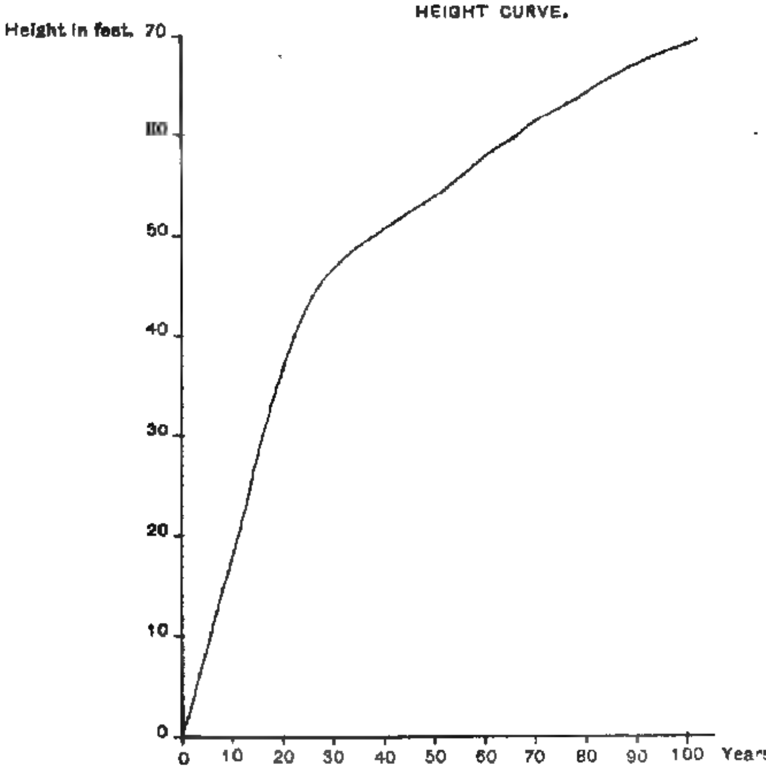
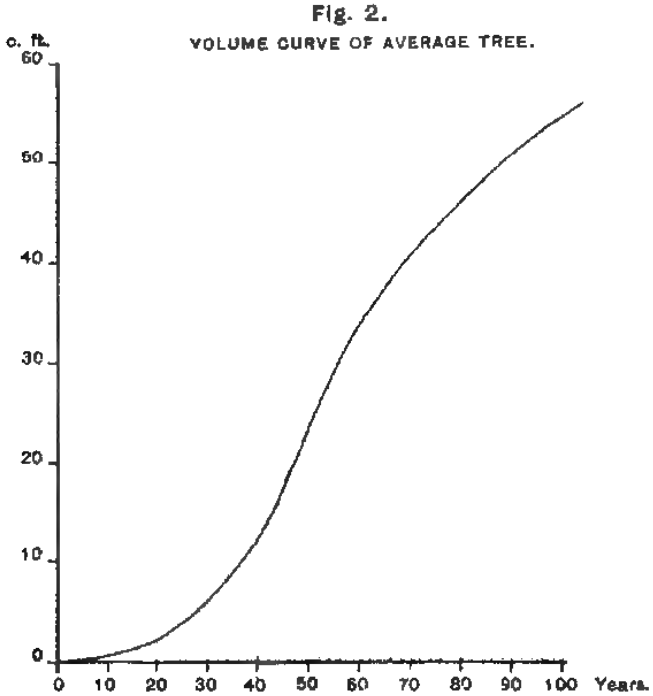


Fig. 2.

VOLUME CURVE OF AVERAGE TREE.



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4. In addition, a large number of teak are dying, whilst others are becoming stag-headed. A modification of the usual coppice-with-standards was proposed, that is, the reservation of as large a number of standards as possible, combined with cultural operations. This really amounts to drastic cleaning or regeneration felling, the result of which will be to produce what may be called a two-storied high forest.

5. To determine the volume-increment of the teak, ten trees were cut and sections taken every ten feet, the first section being five feet from the ground.

6. Five of the trees were sound well-grown trees of as large a girth as possible, the others were dead trees.

7. The dead trees were taken so as to compare the results with the sound trees and find if there was any marked difference in the rate of growth. It was, however, found impossible to obtain any results from the dead trees owing to their being either hollow or the sap-wood having become so rotten as to render the rings unreadable.

8. The results now given deal with the five sound trees. These trees yielded 36 sections. In Plate 43, fig. 1, is given the curve representing the height-growth. This shows the height-growth divided into two well-marked periods, in the first the rate being at an average of about $1\frac{1}{3}$ feet per year and in the second $\frac{1}{3}$ of a foot, *i.e.*, in the first period the rate of height-growth is four times as great as in the second.

9. The end of the first period is probably the time at which the tree had no longer a single leading shoot but began to form a crown. In other words, the bole of the tree is 50 feet and the crown 20 feet.

10. The next curve, Plate 43, fig. 2, shows the volume at different ages. This was calculated for each tree according to the method given in Schlich, Volume III, pages 83—88, branch wood being omitted. The chief point to be observed is the marked increase in the volume-increment between the ages of 35 and 45, *i.e.*, as soon as the principal height growth was completed. This is well shown in the curve showing the current annual increment (Plate 44, fig. 4).

11. The curve in Plate 44, fig. 3, shows the diameter-growth at five feet from the ground.

12. From the curve given in Plate 44, fig. 4, it is seen that the mean annual increment culminates at about 70 years. Now this is the rotation of greatest volume which is generally somewhat below the financial rotation. Also on looking at the diameter curve, Plate 44, fig. 3, we find that a diameter of about 18 inches is reached in 80 years. This is a workable diameter for this class of jungle. The rotation may be therefore safely fixed at 80 years.

13. From the results of enumeration it is found that the average number of trees of each size on a three-acre test plot on each of the lines was -

Line.	3″—6″.	7″—12″.	13″—18″.	19″ and over.
I	24	28	10	2
II	18	34	17	4
III	19	34	15	2
Total ...	61	96	42	8

14. Taking these figures, the possibility can be calculated with the aid of the curves in two ways: (1) Direct calculation of the volume-increment for each class from the mean annual increment (2) Calculation of the volume of the whole growing stock and dividing by the age (Schlich, Volume III, page 92).

The calculations are given below, trees below 3 inches diameter being omitted.

(1) Increment for 100 acres calculated from the mean annual increment :—

3″—6″	average age 18 years	$\frac{61}{9} \times 100 \times \cdot 08 =$	$\frac{488}{9} =$	54·2
7″—12″	„ „ 30 „	$\frac{96}{9} \times 100 \times \cdot 2 =$	$\frac{1920}{9} =$	213·3
13″—18″	„ „ 54 „	$\frac{42}{9} \times 100 \times \cdot 53 =$	$\frac{2226}{9} =$	247·3
19″ & over	„ „ 80 „	$\frac{8}{9} \times 100 \times \cdot 6 =$	$\frac{480}{9} =$	53·3
		Total	...	568·1

Fig. 3.
DIAMETER CURVE.

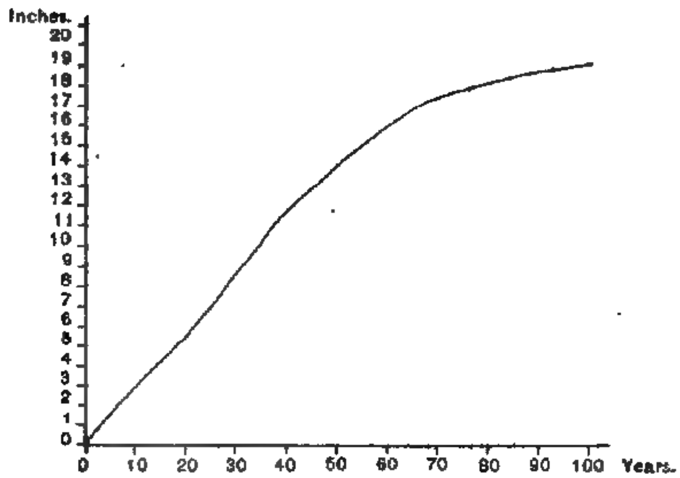
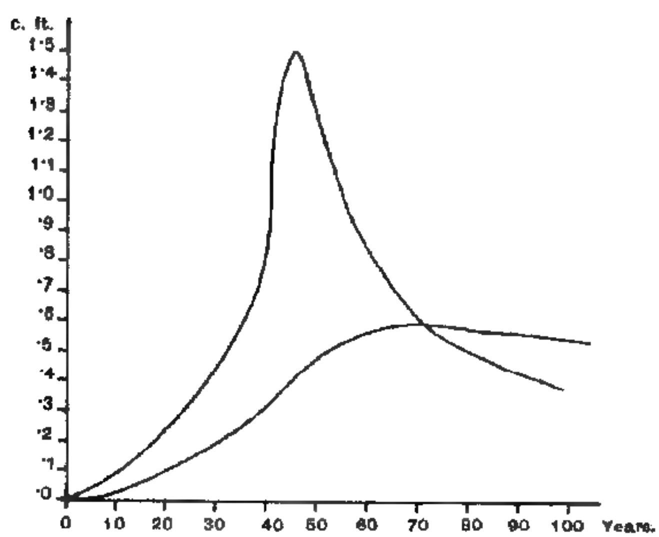


Fig. 4.
CURRENT AND MEAN ANNUAL VOLUME INCREMENT.



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(2) Total volume of teak on 100 acres :—

3″ – 6″	average age 18 years	$\frac{61}{9} \times 100 \times 1{\cdot}8$	= 1,220
7″ – 12″	„ „ 30 „	$\frac{96}{9} \times 100 \times 6{\cdot}3$	= 6,720
13″ – 18″	„ „ 54 „	$\frac{42}{9} \times 100 \times 28{\cdot}8$	= 13,440
19″ & over	„ „ 80 „	$\frac{8}{9} \times 100 \times 50$	= 4,444
		Total ...	25,824

The whole area of the forest is 18,870 acres.

From (1) the mean annual increment for the whole forest is

$$18{,}870 \times \frac{568{\cdot}1}{100} - \frac{1{,}07{,}20{,}047}{100} = 1{,}07{,}200 \text{ cubic feet.}$$

From (2) the mean annual increment will be

$$18{,}870 \times \frac{25{,}824}{100} \div 45 - \frac{48{,}72{,}988}{45} - 1{,}08{,}288 \text{ cubic feet.}$$

15. The average age is taken as 45 since, though the rotation is now 80 years, the trees in the class 19″ and over will be over this age.

16. From the above it appears that the mean annual increment of teak for the whole forest is in round figures 1,00,000 cubic feet.

17. Under the present plan the forest is worked through every 24 years, the girth-limit being fixed at six feet.

18. Now it has been shown that the rotation should be 80 years, at which age the diameter is 18″, *i.e.*, 4′ 6″ girth.

19. Assume that the girth-limit is fixed at 4′ 6′, in which case the amount of timber extracted would be considerably more than with a six feet girth-limit.

20. The total volume of the trees 19″ and over now standing on the ground on 100 acres is

$$\frac{8}{9} \times 100 \times 50 = 4{,}444 \text{ cubic feet}$$

i.e., for the whole forest

$$18{,}870 \times \frac{444}{100} = \frac{83{,}85{,}828}{10} = 8{,}38{,}582 \text{ cubic feet.}$$

Now take a period of 100 years ; supposing that the fellings are made every 25 years, *i.e.*, four times in the period. We may

assume that in 25 years there will be an equal number of trees in the class 19" and over to be felled, since the average age of the 12"–18" class is 54 years, *i.e.*, in 25 years the average age will be 79.

Four fellings will therefore give a total output of 8,38,582 × 4 = 33,54,328 cubic feet.

21. Now in 100 years the increment will be, in round figures, 1,00,00,000 cubic feet, *i.e.*, three times the amount calculated for the actual fellings.

22. It is therefore clear that under a system of high forest selection even when the girth-limit is considerably reduced the full possibility is not nearly worked up to and that this system is therefore unsuitable for this class of forest. The result theoretically obtained above is borne out by the practical result of working. The best method of management seems to be that outlined above which will convert the forest into a series of even-aged coupes with an overwood of well-developed timber trees.

EXTRACTS.

FORESTRY.

It is a truism that with all its horrors war is a great stimulus of industry. It begins by ruining countless industries, but its course points out the weaknesses under which they had been pursued and the lines on which they may be improved. When therefore a war is of the kind which promises a lasting peace men return to industry with enlarged knowledge and are in a position to carry it further than ever before. We will not speak of the wars that connote mere devastation and rapine; they not only kill industries but the desire to revive them; such wars are a thing of the past, the new civilisation will not have them, and perhaps we may be permitted to hope that with this great change in the objects of war we have taken the greatest step towards its extinction and the establishment of perpetual peace. Such remarks may appear to have no bearing on such a subject as forestry; but let anyone read the paper by Mr. E. P. Stebbing on *Forestry and the War* presented to the Royal Society of Arts, and he will at once see that not only had a previous war acted as a great stimulus to British Forestry, but that the present one is likely to prove a fresh and greater stimulus, and not before it was badly needed. Two hundred and fifty years ago, after the civil war had helped to ruin most of the forests of Great Britain, the country became alarmed by the scarcity of oak for the building of its navy, and set about reforesting the land in a lavish manner. But when oak was no longer needed for ships the incentive to reforestation died out, and since then there has been steady depletion of British forests and not even a national policy of forest preservation. The result is that to-day Great Britain is one of the poorest wooded countries in the world. But she has been among the richest of forest lands and can again become so, with the limits imposed by agriculture and industry, if only forestry is restored to its rightful position

once again, and this position it is likely to take as a result of the critical situation created by the present war. This time it is not so much for its navy or for its merchantmen that the pinch of timber has been principally felt; it is for the arts of peace at home—its mining industry, its paper industry, its house-building—that timber cannot be obtained in reasonable quantity or at reasonable prices. The country had grown accustomed to depend on foreign countries for these supplies, the war has prevented the supplies from finding their way to British shores even from neutral countries, except in dribbling shipments; and but for the help of the navy there might have been by this time a positive timber famine in the land, and the complete stoppage of many industries depending on timber. As it is, the small reserves in the forests have been encroached upon in a wholesale manner, making it clear that by the end of the war-period the percentage of woodland will be materially reduced from the insignificant figure of 4 per cent. which now represents it. It may be added that private encouragement and such encouragement as could be given by enlightened societies, such as the Royal Society of Arts, have for long been given towards timber-growing, but the lack of a national policy has stood in the way and even defeated such efforts, the final blow having fallen when in 1866 the import duty on colonial timber was taken off. That even the science of forestry had ceased to advance became clear from the fact that the country could no longer produce the perfect timber of straight stems and free from knots it once grew, and that in consequence the market for British produce declined and British woodlands came in time to be considered less in the light of commercial stocks than as preserves for game and landscape features. For industrial purposes imported timber began steadily to replace home produce, till in 1913 the value of the imports had risen to £43 millions, a growth of £12 millions in five years.

When, therefore, war broke out in 1914, Great Britain found herself almost wholly dependent upon foreign countries for timber supplies and was crippled for a period by the withholding of these. She was taught a valuable lesson and is likely to profit materially

by it. By encroaching upon reserves and by makeshift arrangements with her colonies and others she has, in a way, tided over difficulties, but at the expense of a huge rise in timber prices, while she is faced with the prospect of a huge shortage, even after the war is over, when the demand for timber, not only at home but in the devastated countries, will spring up enormously and prices, instead of falling, may be enhanced. Mr. Stebbing's remedy for the situation at the close of the war embraces somewhat wide and drastic measures. He proposes combination among the Allies, State control over prices, a proposal to Russia to arrange at once for large fellings in such of her forests as are adjacent to suitable ports and placing the timber in depôts against the day of demand, the ear-marking of tonnage for the conveyance of such stocks, to advance money for the initiation of these operations, and lastly, to lease from Russia for a period of years a large area, or areas, and work them ourselves, so that the coniferous timbers that country can supply may be obtainable at reasonable rates. The measures are of course practicable and likely to keep down prices, but there is at least a doubt that at a time when the crisis of the war is approaching, Great Britain, or any other country, would give them attention. Any scheme for setting the industry at Home on a sound footing appears to us more likely to obtain a hearing, and it is therefore of more interest to note what Mr. Stebbing has to say on this point. According to his figures the area of mountain and heath land in England, Wales, Scotland and Ireland runs to 16¾ million acres, all of it bringing in at present a very poor return which may be put down at from a few pence only to a maximum of *2s. 6d.* per acre per year. More than half this class of land is to be found in Scotland and a great part of it is of the kind that yields only a few pence per acre. What is being done regarding this unutilized land? Something of course, but so far chiefly in the way of reports and recommendations: we shall refer to one or two. In 1909 the Royal Commission on Coast Erosion and Afforestation recommended the planting of nine million acres by the State, of which six millions were to be planted in Scotland, and the balance in England, Wales and Ireland. Nothing was done, except some

planting in Ireland. But in the following year a Development Commission was appointed which, so far as scheme-making goes, has done something important. For the first time this Commission has realised that forestry is a national and not a private concern, and if it succeeds in impressing this idea on the State we have some hope of a real advance in the scheme of reforesting the country. In its detail work there is also much to be commended. In England the counties have been divided into natural groups each provided with a forestry adviser. In Scotland an advisory officer to the Board of Agriculture has been appointed and advisory officers in the west and east. In Ireland some land has been purchased and is being worked on the lines of a State Forest Department. The war has of course suspended active operations in all three countries more or less, but the Commission is by no means defunct. In England and Scotland it is working through the actual landowners, who are for the most part corporations, water trusts and large landed proprietors, by giving money advances and stipulating for certain conditions; and before the outbreak of war planting schemes had been begun on Lake Vyrnwy in North Wales, at Thirlmere, in Central Wales, in the catchment area for the Leeds water-supply, on the Talla catchment area of the Edinburgh Water Trust and on the Camps catchment area in Lanarkshire. Business men are beginning to see the possibilities in such enterprises, more especially since the rise in the price of timber has shown prospects of a better return on outlay. It may here be noted that the projects in hand are for the quicker growing timbers, mostly conifers, the stocks of oak are satisfactory and need only scientific conservation. One of the fallacies dispelled by the war and in fact one of those urged to excuse non-compliance with the recommendations of the Coast Erosion Commission is that men untrained in agricultural labour would be unequal to the labour required on forest plantations. The spade and pick work done on the battlefield has shown up this fallacy, and he would be a bold man who could now assert that men returned from trenches would fail under the exactions for hacking and digging in home forests. This, in fact, is the very class of labour for which

forestry work should now be started; the supply will be plentiful and efficient and no better opportunity could possibly offer for commencing on a large scale. There are but three million acres of woodlands now in the United Kingdom while nine million acres more of afforestable land are waiting to be exploited, all of which could not be put to any use more profitable than forestry. Were only 200,000 acres planted out annually, forty-five years would find the whole area utilized and the portions first planted already yielding an outturn. And all this work will have been accomplished for the comparatively small sum of, say, £40 millions.

All this raises the question as to whether with the enhanced prices ruling in Europe it could not be made profitable to send some of the more valuable timbers from India for use in the United Kingdom. Why go to Russia to lease forests when Government possesses the forests in India? The sea voyage from India is longer of course, but on the other hand labour is cheaper. India wants the appliances and cheap transport from the forests to the sea and these are directions in which reform must begin. It pays Germany well to provide special transport rates for goods intended for export, it would pay India equally well to send timber intended for British consumption at specially low rates to the nearest seaport. It might also pay shipping companies to reduce sea freights on such timber if a steady and large export from India be established. Some teak is already carried for use in British shipyards; were the quantity doubled or trebled it might be carried for very much less. In any case the opportunity is offering and it is for India to rise to it. The 43 million pounds worth of timber imported into the United Kingdom in 1913 will probably rise to 60 million pounds shortly. Is all this money to go into foreign hands without an effort on the part of India, a British Dependency, to earn some of it? The outlook is galvanising England itself into an active forest policy; we hope the agitation will re-act on India and that the subject will form one for enquiry by the Royal Commission on Indian industries.—[*Indian Engineering.*]

TREES CURE THEIR OWN WOUNDS.

When a bullet or any foreign body penetrates a tree not sufficiently to kill it, the wound cicatrizes almost in exactly the same way as a wound on the human body heals. If it did not, destructive microbes would enter and cause decay of the tissues.

"Trees," writes Henry Coupin in *Nature*, "are very well equipped for healing their wounds, and, more fortunate than we, an antiseptic dressing is almost automatically applied. As soon as the lesion has taken place the vegetable reacts to the wounded spot. Its breathing at this point is quickened, and at the same time protein matters are rushed to the scene.

"Many plants are provided with secreting canals filled with more or less gummy substances, which are instantly poured out over the wounded surface and protect it. This is true especially of the conifers—pines, firs, etc.—of which the resin makes a swift and impermeable antiseptic dressing."

In trees that have little or no resin the wounded part turns brown. This is due to the appearance of a juice that seems to be a mixture of gums and tannin. And the cells of the tree start into activity, proliferating and filling up the cavity with new cells. If the wound be large, these take the form of vegetable cicatricial tissue, which makes a plug and remains as a scar. In the event that the wound be confined to one of the limbs of the tree, it not infrequently happens that the limb becomes dead and drops off, the wound healing and leaving the tree nowise the worse for the loss of the absent member.—[*American Forestry.*]

FOREST FIRE-FIGHTING.

Quietly the United States Government has been developing towards perfection a fire fighting organization that is the greatest in the world From the stupendous mountain ranges of Alaska to the savannas of Florida, from the watershed of San Diego to the White Mountains, where the President has a summer home, the Government owns extensive forests that are in danger of fire at almost any time, but particularly during September. Each year

there are 6,000 fires to be fought and put out on these vast areas. One of these may be but a smouldering log that has caught from a camp fire and sent out a tentacle or two into the ground brush. Another may be such a fire as raged in the tops of great forest trees in Idaho in 1910 and left a blackened scar 60 miles wide and 200 miles long, and beneath the ashes of it the remains of 78 men who died in the fight for its control

The Forest Service has laboured for ten years to make its fire-fighting organization effective. To-day it is as well ordered as a military organization, as thoroughly drilled, and as thoughtfully prepared in advance of the coming of the foe. In those past ten years the Service has built 3,000 miles of road, 21,000 miles of trails, 18,000 miles of telephone lines. It has established look-outs on a thousand mountain peaks and trained them into scientific observers. It has built networks of fire-breaks that are intended for the time when it may be necessary to turn the demon back upon himself. Every forest supervisor has his school for the training of look-outs, guards and rangers. That school fights theoretical campaigns just as does the Army War College.

The forest supervisor, as schoolmaster, sticks a tack in a map of the region for which he is responsible. There is a look-out attending this school whose station is nearest that tack. It is his turn to recite. He must tell what action he would take should he discover a fire in that location.

He states that he would sight at the fire the instrument he has on a table top into which is built a map. Thus would he be able to draw a line on the map through his station and the fire. Then he would telephone to another look out station calling the attention of its occupant to the outbreak of the fire. That look-out would also extend a line through his station and through the fire. He would tell the first look-out of the angle made by that line. The first look-out would lay the line down on his map. The point at which the two lines met would be the location of the fire.

Then the look out would call up the ranger cabin and inform his superior that there was a fire at the given point. His responsibility would have ended.

The schoolmaster then calls upon the ranger for a statement of what his action would be with a fire at this point in his domain. The ranger states that at this point there is heavy timber, that a draw leads up into a very valuable forest. It is a real emergency. The loss will be great if the fire is not stopped. It is a task too big for one or two men.

He jumps on his horse and dashes to a settlement two miles distant. He has an understanding with certain settlers, with a garage keeper and with a liveryman to come to his aid in case of an emergency. These are the members of his reserve army. In 15 minutes he has twenty men in automobiles and is rushing for the scene of the fire.

The flames are running like mad up the canyon. Fire is one thing that runs faster up hill than down. The ranger estimates the speed of the fire and the length of time it will take his force to cut a break across a narrow place in a gulch two miles further up. He believes he can establish a gap that the flames will not leap before that point is reached.

His men run with augers and begin boring holes in the great trees along the strip where the fire-break is to be established. Into these holes are thrust sticks of dynamite. It will cut a tree down quicker than it may be felled with an axe. With explosives a swatch is cut across the canyon. It is a crown fire, which is to say that it is raging in the tree-tops. If it does not jump to the tree-tops beyond the felled trees the ranger and his 20 men may be able to fight it back.

But it does jump. The wind takes a brand across the gap and it ignites the tops of the trees beyond. The preliminary campaign has failed. The fire will get into the big forest. This converts the battle into a size which is beyond the force of the ranger. He rushes to the telephone and calls for help from the forest supervisor.

This supervisor has worked out a means of co-operation between the rangers and guards of the different districts under his supervision. He begins the mobilisation of his forces. Over the telephone he is able to issue instructions that will concentrate

scores of trained fighters. These are to report at certain points and take charge of the work there.

He has a highly developed method of getting great numbers of volunteer fire-fighters. The railroads are directly interested in putting out all fires and will throw all available forces of workmen into the breach. Lumber companies are in a similar position. Labour agencies near by have been arranged with and send out calls for men who will work at fighting fire. There are warehouses near by, owned by the Government, and in which are stored hundreds of kits of tools and provisions for men. The volunteers are supplied with these and placed under the command of the rangers at various points. Volunteers may be rushed by special trains from the nearest cities. Ten thousand men may be mustered in a day or two for the fighting of this fire demon.

This entire campaign may be fought at the rangers' school. It may be necessary at any moment to actually fight it in some of the great forests of the West.

But the campaign of fire-prevention is pursued with no less determination, and throughout the year. The laying down of a forest ground plan of breaks, trails, telephone lines, look-out stations, and such is but a small part of the prevention work. Much of it is educational.

There is a campaign, for instance, which has as its object bringing the man who goes into the woods to a proper appreciation of his responsibility. At first the Forest Service used warnings that were threats. The law assessing fines and imprisonment was quoted. Later it was decided that a threat was unpleasant, and therefore had no place in vacation land. Psychologically, said the authorities, a threat arouses antagonisms. Let's be pleasant about these warnings. So now they are putting up signs which read something like this :—

"Going hunting? Well, watch the matches."

"Did you put out your camp-fire?"

"Don't burn up the forest."

There are admonitions to be careful at all the waterholes, at all the camping places. The rangers have even built foolproof fire-

places at certain camps, out of which fire cannot get into the woods The literature which tells where to hunt also carries the first warnings and information as to how danger may be avoided. The tobacconist at the resort hotel is furnished with slips for distribution containing information and fire warnings and on the opposite side of which he may print his own advertisement. There is the ever present but pleasant warning of the danger that lurks in the reckless use of matches and neglect of camp fires.—FREDK. J. HASKIN in "The Fireman's Herald."—[*Indian Engineering.*]

LAC CULTIVATION IN THE KARAULI STATE.

The Report on the Administration of the Karauli (Rajputana) State for 1913-14, covering the period from 1st September 1913 to 31st August 1914, has recently been issued, and from it we extract the following passages relative to the lac industry :—

As mentioned in the last year's report the State Forest Officer and Inspector of Forests having been trained in lac cultivation at the Pusa Agricultural Research Institute, it was contemplated by the Durbar to carry out experiments in lac cultivation in the State during the year under report. With this object in view a maund of Kusumb brood lac was obtained from the Rewah State Forests at Umaria at a cost of Rs. 30, and the services of Mr. C. S. Misra, B A., First Assistant to the Imperial Entomologist of the aforementioned Institute, were secured for a month, so that the operations might be carried out with his advice and under his supervision.

The one maund of brood lac, consisting of 800 sticks, was brought from Umaria to Karauli on the 15th November 1913 by the Forest Officer and Mr. C. S. Misra, who had visited the place for this purpose. Mr. Misra took great pains in examining the localities selected by the Forest Officer for starting the lac cultivation. From the 16th to 21st November he examined all the Rundhs and Forests lying within a radius of ten miles of Karauli town, and prepared an elaborate note containing many useful

and valuable suggestions relating to lac cultivation in the State Forests for which the Durbar are exceedingly indebted to him. 784 sticks in all were put on various trees in different localities approved by Mr. Misra, as shown in the following table, the remaining sticks being either crushed or otherwise soiled during transit. As the sticks were cut at Umaria on the 10th November, and from these the larvæ began to emerge on the 7th December, the work was taken in hand on the 8th December.

Dates.	Localities	Description of trees.	Number of sticks put on.
8th and 9th December 1913.	*Rundh Kalan.* Bed of river Bhadraoti	Ber (*a*) trees	127
		Palas (*b*) trees ...	65
	In Boringa .	Palas and Anjeer (*c*) ..	52
	On the banks of the river.	Ber trees ...	28
		Palas trees ...	49
	In Lohari Gadhar ...	Palas trees ...	59
10th and 11th December 1913.	*Rundh Kakardah.* In Bhanwar below Sera Dhay.	Palas trees ...	190
		Ber trees ...	36
		Siris (*d*) trees ...	4
		Khair (*e*) trees ...	4
	In Bilai ...	Palas trees .	20
	In Khoh Nimbheara ..	2 Kusum (*f*) trees ...	150
		Total .	784

It is to be regretted that the experimental operations did not prove more successful. It is reported that the failure was chiefly attributable to the following causes :—

(1) As fatty incrustations always suffer if exposed to hot winds, a considerable quantity of lac insects was destroyed by the hot winds, which continued to blow during the months of May and June, more especially on the 29th May, when the temperature rose to 112°.

(2) Many of the branches of the trees inoculated with lac insects were destroyed by monkeys.

(3) A number of branches of trees on which lac insects had been put were unwittingly cut down by cattle-owners and wood-cutters, who were severely dealt with, but their foolish action had destroyed the cultivation from the healthiest trees situated in very suitable localities, and the damage thus done could not be made good.

The experiments have not caused expense, as will be seen from the following table :—

		Rs.	a.	p.
Expenses—				
Price of Kusumi brood lac		30	0	0
Railway freight, etc.		10	0	0
	Total	40	0	0
Price of brood lac obtained in July		14	1	0
Freight, etc.		5	8	6
	Total	19	9	6
	Grand Total	59	9	6
Income—				
Income from sale proceeds		56	15	0
Balance to be made good		2	10	6
	Total	59	9	6

The results of the cultivation of brood lac obtained in July 1914 will be mentioned in the next year's report.

The Durbar acknowledge, with thanks, the timely assistance and advice given by the Principal, Agricultural Research Institute, Pusa, and the First Assistant to the Entomologist, Mr. C. S. Misra, in the introduction of lac industry in the State. Though the first attempts may not be successful it is hoped that good results may eventually be obtained.—[*The Indian Trade Journal.*]

NOTE.—

(*a*) Ber—*Zizyphus* sp.

(*b*) Palas—*Butea frondosa.*

(*c*) Anjeer—*Ficus* sp.

(*d*) Siris—*Albizzia* sp.

(*e*) Khair—*Acacia Catechu.*

(*f*) Kusum—*Schleichera trijuga*

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FOREST RESERVATION IN BURMA.

BY H. W. A. WATSON, I F.S.

The question of laying down and putting through a strong policy for future reservation with the object of taking in all areas capable of procuring marketable timber that are unsuitable for permanent cultivation and checking the inroads of the taungya-cutter.

A glance at the map of most forest divisions in Burma shows a number of forest reserves of various sizes, and that, these reserves are, for the most part, more or less remote from the more populous parts.

The chief reason for the former appears to have lain in the suspicious attitude of the authorities to reservation and, for the latter, to the boundaries being thrown back in deference to the wishes of the villagers.

Moreover, owing to the value of teak overshadowing that of all other species, it is only in recent years that reservation in the interests of the latter has received serious consideration.

2. In throwing back the boundaries of the reserves in deference to the wishes of the villagers, we certainly have not considered the best interests of the community.

In accessible areas the throwing back of the boundary has resulted, so far as the excluded area was concerned, in the removal of all marketable timber by the trader and the serious depletion of the immature stock by the wasteful use of the villager. Superimpose a trade demand for firewood and areas, that were at one time capable of producing marketable timber, are in a couple of decades reduced to wastes that are only reclaimable at an enormous outlay.

What the result of excluding forests in deference to the wishes of the villagers has been is emphasised by the fact that it is now necessary to seriously consider the question of forming village forests, *i.e.*, within a generation the villagers and traders have squandered the resources of the accessible areas.

3. To turn to the damage by taungya-cutting tribes, little serious effort has so far been made to check their inroads.

The area that has been notified in which taungya-cutting is prohibited is comparatively negligible and action on these lines only tends to concentrate their efforts elsewhere.

The constant pressure of trans-frontier taungya-cutting tribes is a very serious menace. Large areas of higher evergreen and pine forest have been reduced to grass wastes and in the lower levels their depredations have resulted in large areas being overrun by creeping bamboo to the extinction of tree-growth. To classify the remote hill forests as permanently inaccessible is an easy way of begging the question.

We know little about their economic possibilities and are apt to forget that our prehistoric methods of timber extraction are susceptible of vast improvement. Timber transport by airship, a century hence, is no wilder an improbability than was wireless telegraphy a century ago, and while forests may be destroyed within a generation, it takes many generations to replace them.

4. The Forest Officer in the past was, to a great extent, compelled to take too narrow a view, but this view is broadening and the same process of evolution has lessened the suspicions with

which the civilian authorities formerly regarded our operations. In the past we were compelled to reserve in patches and to exclude much of the accessible areas.

Should we continue in the future to allow, without protest, what remains of the unclassed forests to be turned into irreclaimable waste, we shall justly lay ourselves open to the reproach of future generations.

5. As a result of our past policy, the less accessible areas are reserved to a great extent and the more accessible steadily deteriorating, though burdened with troublesome regulations, made in a vain effort to stay their ruin and impossible to enforce efficiently.

6. The only remedy for this state of affairs appears to lie in the reservation of all tracts capable of producing timber or fuel.

In carrying out this reservation all lands suitable for permanent cultivation should be excluded and definite areas should be set aside for such communities as must exist by taungya cultivation.

The settlement might be by townships, or any other suitable unit, and should be carried out on broad-minded lines. To begin with, unnecessary bogies, such as that relating to the use of fire in areas unlikely to be brought under fire-protection, should be eliminated from the proclamation. We should also revise our ideas on the subject of what constitutes trespass by man and beast and modify the ruling, limiting the exercise of rights to the number of houses actually inhabiting a village at the time of settlement.

The area, within a reasonable radius of habitations, should be reserved for management mainly as communal forests, the original inhabitants getting their produce free, and provision being made for immigrants, being so far as possible provided for at privilege rates. The profit on the management of such communal forests should be utilised for the benefit of the villages in their vicinity.

It should not be considered trespass by man or beast to stray within a reasonable distance of a right of way. Above all, the necessity for dealing with unimportant technical offences in a broad minded way should be impressed on Divisional Forest Officers.

7. The principal arguments that will be adduced against action on these lines are—

(*i*) The liability of the ignorant villager to oppression by the local forest subordinates.

This argument is frequently adduced in a vague manner.

There are many villages in exclusions surrounded by reserves that have to depend for all their requirements in the shape of forest produce from these reserves. If subject to undue oppression, the position of the inhabitants of such villages would be intolerable and they would migrate elsewhere. I have always found the inhabitants of these enclosed villages contented and independent. Certainly the inhabitants of the larger groups of villages are not so unsophisticated as to tolerate oppression.

If, however, this argument is considered serious, the remedy would seem to lie, in the case of portions of reserves managed mainly as communal forests, in vesting either the senior headman or a responsible elected representative of the community with the position of forest subordinate.

(*ii*) That the Forest Department is not sufficiently staffed to manage the increased area of reserves.

The remedy for this rests with Government. Under our present system of management undue stress is laid on revenue production to the exclusion of local interests. A 60 per cent. actual profit is expected from the forests instead of a legitimate 33 per cent. Whatever increase of staff is requisite will doubtless be provided in time if the matter is properly represented. We must, moreover, bear in mind that our subordinate staff is progressing both in capacity and in morale and that by abolishing the unclassed forest in favour of reserves we concentrate our energies on one group, waste land subject to few or no restrictions being substituted for our present unclassed forests with their numerous rules and regulations. Some very simple scheme of management will suffice for the areas to be worked as communal forests and by giving the village headman some authority in the management we increase his prestige and enlist his co-operation. The main point is to confine the operations of the trader to areas where they will not

interfere with the satisfaction of the legitimate demands of the villagers.

8. The question of allotting adequate areas to the taungya-cutting communities will undoubtedly present difficulties. Even employing the liberal formula, *viz.*, number of households multiplied by average area cultivated per household, multiplied by average rotation, and doubled to allow for land that is unsuitable for taungya-cultivation, judging by past experience it will be found that the communities, if left to themselves, will largely squander the resources of their areas in little over a generation, owing to their improvident patchy methods of cultivation and the unrestricted use of fire.

A visit to the south-west part of the Southern Shan States will show that, in cases of congestion of population, the taungya-cutting communities have adopted one of the following alternatives :—

(*i*) Terraced cultivation.

(*ii*) Burning of the soil mixed with cow-dung.

(*iii*) Fire-protection.

This last is particularly interesting and has been in force on their own initiative in the case of some of the Karenni tribes for many years. Experiments as to the best methods of taungya-*cultivation, where the area is restricted, might, with advantage,* receive the attention of the Agricultural Department.

The solution will probably lie largely in fire-protection, combined with a division of the area into blocks to correspond with the number of years in the taungya rotation. This solution, when arrived at, should be enforced by law.

9. It seems obvious that only by some such system of universal reservation of all forests of value can the present waste be stayed and the declared policy of Government, as laid down in Circular No. 22F., dated 19th October 1894, be carried out.

No system of reserving patches as fuel and fodder reserves will suffice to meet the growing demands of local communities. A perusal of the literature on the subject shows that past efforts in this direction have proved futile.

10. By systematically taking action we resolve the classification of Government land into—

(*i*) Reserved Forests (Commercial and Communal).

(*ii*) Waste land of no commercial importance, including absolute waste and areas abandoned to the taungya-cutter.

In the case of the latter group, it may be necessary to accord some protection to trees along roads, streams and within municipal areas ; but otherwise, these should be abandoned absolutely.

11. If these views are accepted, the most urgent townships or other units should be taken in hand without delay and in divisions, where further reservation is urgent, instead of adding the customary patch, the whole township concerned should be notified and dealt with. Wholesale reservation at one time will be found less disturbing to the villagers than the addition of patches at intervals.

12. To conclude, it would seem that it is the duty of the Forest Department to represent strongly and continually the great waste of the forest resources that is going on and to press for remedial measures. Should Government not see its way to legislate for these, the responsibility no longer rests with the Forest Department. The longer the delay, the greater the stretch of irreclaimable land that will accrue and remain as a reproach to the administration.

NOTE ON FOREST POLICY IN BURMA.

BY J. W. A. GRIEVE, I.F.S.

A very large percentage of the Province consists of ranges of low hills and valleys, which are, owing to their steepness, want of soil and so forth, usually unfit for the production of permanent field crops. A large proportion of these areas has already been taken up as reserved forest, but much still remains as so-called unclassed forest, that is, waste land, often uninhabited, or at most containing a few scattered villages. It is with these "Unclassed forests" that this note is more immediately concerned. Apart from conditions of climate or other local peculiarities which must

be dealt with on their merits, it may be safely laid down as an axiom that the interests of a country will be best served by producing from each class of soil that crop which will bring in the largest permanent return Many of these unclassed forests contain much valuable teak, while a still greater number contain timbers which only require to be placed on the market at a reasonably low cost to ensure their ready sale at remunerative rates.

It is, therefore, obvious that they will eventually prove a very large source of revenue to the country, and as such should be preserved against destruction : for it is inconceivable that in such broken country any known crop could profitably replace the forest. The factor most urgently required for their development, as for that of the country generally, is an increase in the labouring population. To secure this object, and at the same time to utilise, to their fullest extent, the vast sources of forest capital contained in the Province, must be the key note of whatever Forest Policy is ultimately adopted in the country. These unclassed forests are gradually being examined with a view to their reservation, but owing to the ludicrously inadequate staff of Forest Officers in Burma, progress in this direction is necessarily extremely slow. Under present conditions, villagers are given every inducement to settle in such areas. *They can take up any land and cultivate it as they please.* Some form of taungya cultivation is usually practised. In forming forest reserves, the practice is to exclude a very considerable area of land usually incapable of carrying any permanent crop other than forest, in order that any existing village may obtain its domestic requirements free without entering the Reserved forest! That such a policy can exist, gives one furiously to think! We take up enormous areas of reserve, which contain millions of tons of unsaleable material of the kind required by the population, and we prevent that population from using it. On the other hand, we deliberately give over to the villager large areas of ground unsuited to the production of any crop other than forest with the knowledge that, in the course of time, he will render them unfit for any purpose whatsoever, including the production of the very material, the supply of which the land set aside to provide? It

therefore appears obvious that the reserved forest does not usually attain the object described in paragraph 2 of Appendix V of the Indian Forest Code, 7th edition, which defines the objects of administration of State forests, any more than does the permission to destroy certain areas of unclassed forest permanently provide for the supply of the domestic requirements of the villager. There can be no doubt that such a policy is inherently a bad one. Owing to the vast areas still unpopulated, its evil effects are so far negligible, but with any marked increase of population a day of reckoning will be bound to come. Every village will be surrounded with an area of unproductive scrub and will eventually have to seek its requirements from the Reserved forests. What is wanted is a system by which all land, which can only profitably support a forest crop, would be permanently set aside for that crop, provision at the same time being made for the wants of a labouring population sufficient to work it. It is a recognised fact that tea, coffee, rubber or any other agricultural estate, must have a sufficient labour-supply conveniently situated to work it. In the case of forest estates, which cover enormous areas, this is even more essential, and the obvious method of providing it is by means of forest villages situated at convenient intervals throughout all reserves.

The lines, on which such villages are run, vary greatly with local customs and peculiarities, but the main principle is, that the villagers are given land to cultivate free of charge or at a very low rent, and free forest produce for all domestic requirements, in return for which they give so many days' labour on forest work free or at reduced rates. They are exclusively under the Forest Department who, of course, are responsible for the carrying out of the ordinary laws of the country. The villagers are given cultivation sufficient to produce food for their own consumption, and during the period when no field work is possible they do all the road work, thinnings, fire-protection and so forth, for payment as may be agreed upon. Moreover, in the forest village lies the solution of the much-vexed taungya question. The taungya-cutter is like a forest fire,—he is a bad master, but, under control,

he is the best servant the forest can have. Large permanent villages are of less use than those which can be moved from time to time to different work centres, and it ought to be possible, by means of some system of controlled taungyas, to effect the planting up of the whole forest at a minimum cost, and in such a way that by the end of the rotation, the first year's plantations should be ready for felling over again with the subsequent repetition of the taungya process. That this is an ideal that will take many years to work up to must be admitted. The enormous tracts of land still remaining unsettled, the incorrigible laziness of the Burman, and the corruptness of the subordinate staff are all factors that militate against the successful working of such a scheme. Greater even than any of these is the want of controlling staff. Until this is remedied, little or no progress in forest development can be expected, and for so long will the colossal wastage of forest capital of, perhaps, the finest forest property the world can show, continue. The war has of course set things back in these as in most other respects, but it has not been responsible for what must be held to be a wrong policy. Prompt measures to revise this at least can be taken. The longer it is put off, the greater will be the destruction of forest capital, the larger the denuded areas which tend to become worthless and the greater the inconvenience to the settled population. That the forest staff is now numerically insufficient to deal with the areas already under its control is no argument against the preservation of valuable forest from destruction. The other branches of Government Service are equally short-handed and consequently equally unable to administer these tracts. On the other hand, the idea that a reserved forest is an area hermetically sealed against the supply of all local demand or against the ingress of the labouring population it so urgently requires, must be thoroughly grasped by forest official and villager alike.

PRIZE-DAY, FOREST RESEARCH INSTITUTE AND COLLEGE, DEHRA DUN.

The Annual Prize-Day of the Provincial Service Class was held on the 10th July at the Forest Research Institute, Dehra Dun, *in presence of Mr. Hart, Inspector-General of Forests.*

The proceedings were opened by Mr. B. B. Osmaston, who read the following report :—

"MR. HART, GENTLEMEN,

The Members of the Provincial Service Class who are now about to leave us are the third batch trained under the new conditions.

The class is a small one, consisting of eight men only.

Their course of studies has extended over full two years, during which period, in addition to lectures in the class room, they have spent 14 months on tour, including two in South India. On these tours practical instruction was given in Engineering, tree-marking, Sylviculture and the framing of Working Plans.

I am glad to be able to say that the class, as a whole, is the best we have had.

Even the man at the bottom of the list has succeeded in getting 70 per cent. of full marks, and the top man has got the very creditable total of 82 per cent. Four out of the eight have got more than 75 per cent. of full marks, thereby obtaining "Honours," and the rest are awarded the ordinary Pass Certificate. These good results are no doubt largely due to intelligent and sustained application, but also partly to the fact that owing to the smallness of the class, the Instructors were able to give the students an unusual amount of individual attention.

The conduct of the students has been good.

Their health, on the other hand, has not been quite satisfactory.

The members of the class have all shown considerable keenness at games, but with a single exception, they have not greatly distinguished themselves in this line."

The following is the list showing the order of merit and the winners of the various prizes :—

CERTIFICATES.

1. Sochindra Nath Mitra (Bengal).	Honours Certificates
2. Muhammad Abdul Hafiz (Madras).	
3. Rajendra Nath De (Assam).	
4. Anil Kumar Adhikari (Assam)	
5. Jai Krishan Nanda (Kashmir)	Ordinary Certificates
6. Troilokyanath Hazarika (Assam).	
7. Puranic Krishnaswami Rau (Mysore State).	
8. Roland Harry Mitchell (Madras).	

MEDALS AND OTHER PRIZES.

Gold Medals.—For Honours Certificates.

Hill Memorial Prize (best in Sylviculture).—S. N. Mitra.

The Indian Forester Prize. For general proficiency.—S. N. Mitra.

The Hon'ble Member's Prize Most promising student.—R. N. De.

Inspector-General of Forests' Cup. Best all-round athlete among outgoing students. R. H. Mitchell.

Silver Medal.	(Forestry)	...	M. A. Hafiz.
Do.	(Botany)	...	S. N. Mitra.
Do.	(Surveying)	...	A. K. Adhikari.
Do.	(Engineering)	...	R. N. De.

Championship Cup. Winner of most events in the athletic sports (all four classes).—R. H. Mitchell.

The certificates and prizes were distributed by Mr. Hart, after which he gave the students the following address :—

"STUDENTS OF THE PROVINCIAL SERVICE CLASSES,

In the first place I have to say a few words to those of you who have now completed your training and are leaving the Research Institute. I am glad to hear such a good report from the President about you. None of you have failed to obtain a pass certificate and the proportion of Honours men is unusually high. You have

evidently worked hard and well and, in addition, have been fortunate in that, being a small class, it has been possible for your Instructors to give you more individual attention than usual.

This is probably the last year in which the Provincial Service students will have their prize-day in July. In the first place, the finish of the course at this time of the year means that the final examinations are held at about the worst season of the year and this is hard both on the students and on the staff. Then, as long as we have the Ranger class with us, it seems desirable that there should be one joint prize-day for all the students of the Institute and College combined and not two separate functions, neither of which has been a very impressive ceremony of late years. So next year we intend to have a combined prize-day at the end of March. This will necessitate curtailing the length of the Provincial Service course for the years 1915—17 and 1916—18 to 21 months, which is unfortunate but cannot be helped.

It would not be quite true to say that every one of you has received a prize, but still I think it must be admitted that for so small a class the number of prizes given is large. Among these prizes were four valuable gold medals. In this matter your successors will not be quite so fortunate as you have been. The Board of Forestry considered this question at their meeting held last March. They decided that in future only one gold medal should be given to the man who holds the first place at the end of the course of training, provided that he also obtains an Honours certificate, and I think I may say that the Government of India are likely to accept this recommendation. You must not think that in making this proposal the members of the Board of Forestry were guided by reasons of economy only. They thought that gold medals were becoming a little too common and that it would be a much greater honour to be the one gold medallist of the year than to obtain a gold medal under present conditions. The student who secures the gold medal under the new rule will be a marked man throughout his service to a much greater extent than the holder of a gold medal is at present.

As a class you have done exceptionally well at the Institute, and I hope that you will all continue to work hard and honestly during your service in the department. If you do, you have excellent prospects ahead of you: but you must remember that those prospects depend on your future work in the jungles and not on the work, good though it is, you have done in the course of your training.

Those of you who remain with us either for one or for two years more will have the advantage of living under pleasanter conditions than your predecessors during the time you spend at Dehra Dun. Through the energy displayed by the Executive Engineer, Mr. Jones, the new buildings are now ready for occupation and you will all live together in comfortable well-found quarters. By next year you will have a fine playing field of your own with ample room for cricket, football and hockey. I hope that under these conditions you will all take a real interest in athletics generally. You must remember that health and strength have a great deal to do with the successful career of a Forest Officer. You have to build up the athletic records of the Provincial Forest Service classes and, in addition to your work, I expect to see you take a keen interest in making and maintaining those records as high as possible.

Government has provided a commodious club house for the students. It is not very well furnished at present, but that will be seen to gradually. I want you to understand that for the rest of the club fittings and property you must depend on yourselves. It is obviously impossible that the club house should be fitted out completely at the start, and indeed it is probable that if this was done for you straight away the club property might not be treated with very great respect. For the next few years, therefore, you students must be content to do as the Forest Officer has to do throughout his service, that is, to work for the benefit of posterity. I think, also, that the future of the club house should not be regarded as the business of the European and Anglo Indian students only. The club house will be used as a sports pavilion and for this purpose and as a reading-room, etc. it will be open to

THE NORTH KAMRUP GAME SANCTUARY, ASSAM

BY A. J. W. MILROY, I.F.S.

To be in charge of a Game Sanctuary is a piece of luck that comes to few, and an account of what is being done in this Province to preserve the fauna of the country may be of interest. Not so many years ago, Sir Harry Johnstone severely criticised the Government of India for its indifference on the subject of game preservation, but Assam had already established a number of sanctuaries, and since then a Game Association has been formed in one of the Tea districts for the purpose of managing certain shooting preserves in conjunction with the Forest Department. The Kamrup Sanctuary, of 57,600 acres, was gazetted a Reserve in 1907, the main object in view being the saving from extinction of such *rhino* as still survived locally. It is situated in the extreme north-west corner of the district, bounded on the west by the Monas river, on the north by Bhutan, and on the east and south by waste land, so that its reservation inflicted no hardships on any of the inhabitants of the district. Across the Monas is another Sanctuary under the D. F. O., Goalpara.

The south portion of the Reserve is chiefly swamp with higher grass lands in between, a nasty treacherous piece of country, which seems to have become more water-logged since the earthquake of 1897. *Acacia Catechu* and *Albizzias* are sprinkled over the grass savannahs.

The central portion is alternating prairie and dense moist evergreen forest, containing almost impenetrable patches of cane: some of the more interesting trees are *Morus laevigata*, *Amoora spectabilis*, *Cedrela Toona*, *Duabanga sonneratioides*, *Cinnamomum glanduliferum*, *Artocarpus Chaplasha*, etc. The north portion

slopes gently up to the Himalayan foot-hills, and consists of grass afforested, often rather sparsely, with deciduous and fire-resisting species such as *Acacia*, *Albizzia*, *Gmelina arborea* and various *Bauhinias* On account of the remoteness of the Reserve from any market the present demand for timber from it is practically nil.

There were formerly three favourite shooting grounds for rhino in this part of Kamrup, and two of these have been included within the Sanctuary ; the third was omitted, possibly because all the rhino had been shot out, but as they are again to be found there now, the Local Administration has been asked to sanction the reservation of the area as an addition to the Sanctuary, as it is uninhabited and, for the most part, undrainable swamp

There can be no doubt that Government acted none too soon on the rhino's behalf. His horn and flesh are of such value to Hindus that a number of local shikaris made their livelihood by killing rhino, and, but for the thickness of his skin and wonderful general vitality, and the poor quality of the shikaris' powder, there would be no rhino left alive here to-day. I have heard of 17 native bullets being dug out of a dead rhino, some of which must have been in him for years.

While it is a desperate animal to attack on equal terms, it is easy game to the pot-hunter on account of its habits of using the same tunnels through the grass and of depositing its dung in the same places, so that, given a properly placed *machán* and patience, success is bound to come sooner or later to the happy shikari.

Europeans and native sportsmen using elephants also did the stock great harm by shooting an undue number of cows, and there are many men who can show trophies from cows and none from bulls. The sexes are so similar in appearance that no one can be blamed for making mistakes on this score ; the mischief was done by following up family parties of rhino. A bull and a cow with her calf are commonly found together, and on being disturbed the bull generally clears out at once, leaving the cow to face the danger while her calf makes for safety. As a rule, under these circumstances, the cow asks for trouble by charging her pursuers bald-headed, and consequently usually gets it in the neck. Another

annoying habit the cow rhino has is that of leaving her calf in some hidden place while she goes off to graze, so that any one coming on her track thinks he is after a solitary bull, until after a time the calf chips in unexpectedly.

The Sanctuary has only once been invaded officially, when Lord Minto shot here in the beginning of 1909.

His action created a considerable amount of resentment amongst the Europeans of the Province, and it is only fair to say that he had been completely deceived as to the state of affairs. His information was that this Sanctuary swarmed with rhino, and that there were none outside, and by the time that letters appearing in the Press had undeceived him on this point, the whole *bundobust* had been made and the shoot had to go on as arranged.

No one could accuse Lord Minto of not being a sportsman, and, as soon as he understood that he had been misinformed, he promptly limited himself to the bagging of one rhino, and did not allow his suite to shoot at all.

He got his one rhino but only after a deal of trouble. Rhino are difficult animals to drive at any time, and on this occasion the beating arrangements were not in the hands of the then D.F.O., Mr. D. P. Copeland, who knew the locality inside out, or of any one with local knowledge. Attempts were made to drive the rhino by *force majeure* (as represented by over 70 elephants) in directions that they did not wish to go. Now the rhino is not an animal that allows itself to be put upon, and what happened over and over again was that a rhino disturbed by the advancing elephants would trot out, survey the long line and then charge with its unearthly burbling at what appeared to it to be a weak link in the chain. The line as invariably broke, for the elephant that will face a rhino is a real rarity, and much time was lost in getting the quaking 'hathis' (elephants) back into line for a further advance.

One elephant, caught as it was turning round to bolt, was bowled completely over by a rhino. A well-known staunch tusker was in one beat posted as a stop, but had the bad luck to be in the way of a particularly irate cow, which, with its half-grown calf, was not in any mood to be stopped. The old tusker, somewhat

surprised not to hear the expected bang from his back and see the evil beast swerve off, had to do something for his reputation, so he bravely pinned the cow down with a tusk on either side of her neck, but the calf starting to slash him from behind he had to release the mother from Chancery and fly for his life.

As most people know, the offensive weapons of the Indian rhino are his tushes and not the horn, and, I must say, it is a fearsome thing, if one has time to look back, to see the open red mouth with the wicked tushes close behind one's elephant's heels.

I can never understand why those who manage shoots for Princes and Viceroys always aim at driving all the game to them; perhaps it is to guard against blank days.

If any one wants excitement without undue personal risk, he can always be sure of getting it by following up a rhino on an elephant, whereas it must be difficult to fail to down a poor old rhino driven up to one in the open. There were considered to be 15 or 16 rhino in the Sanctuary at the time of Lord Minto's shoot.

Arrangements had been made to hold a census during the cold season just over but, on account of men joining the Officers' Reserve, I was given charge of a second Division and had to postpone operations. We do not mean to try and count every rhino in the place, but only the cows with calves. The enumeration will be done by taking very careful measurements of the foot impressions. If, as I hope and believe, we find that there are indisputably as many as 12 cows with calves we can afford to feel confident as to the future of the stock, as there would be a number of immature cows and cows about to calve, but without a calf at foot, not reckoned in our total

Rhino shooting is now forbidden in Assam except with the Chief Commissioner's permission, but advancing civilisation and more especially the graziers' herds are opposed to any increase of the species outside Reserves. Although the rhino individually is a sturdy and independent beast, yet, as a species, it is easily discouraged and does not appear to thrive except under conditions where it is not disturbed.

There is every hope of the rhino in the Reserves increasing considerably in numbers. It is a slow breeder and the areas set apart for it are necessarily so confined that I doubt if it ever will get plentiful enough again to become a regular beast of the chase, but we hope that it will so increase as to permit us to catch calves for zoological specimens, either by pitting or in some other way. Considering that a man can sell a dead rhino, horn, skin and flesh, for nearly Rs. 400, poachers are obviously tempted to have a go at them, and rhino shooting and illegal elephant hunting are the only forms of poaching that we have to consider seriously: deer are common enough outside. Rhino, undoubtedly, are occasionally killed in Sanctuaries. In Goalpara raids are sometimes threatened by truculent Nepalese from Bhutan, while those Sanctuaries that have the Brahmaputra as one boundary are obviously very difficult to keep inviolate: in fact, a Conservator a few years ago had to deal with a case where a forest guard had helped to kill a rhino.

The Kamrup Sanctuary is fortunate in its boundaries, and there are not, as yet, any Nepalese across the border in Bhutan. The whole *bundobust* for killing an animal and disposing of the loot has to be so complicated, except in cases where there is access to a foreign country or navigable river, that a number of people must be in it and some one is sure to give it away, even if too late to do any good. The only reported case in Kamrup occurred recently when some right-holders say they found a dead rhino. Investigations are being made to see if it was a case of lead-poisoning. Provided that we are sufficiently generous in rewarding those who supply us with information, there is no reason to fear that this sort of poaching will increase.

There were rumours some years ago that elephants had been caught in the Sanctuary, and a tusker was certainly shot by a party of Bhutanese. In consequence of a complaint made to the Bhutan authorities, soldiers were sent to the offending village and carried off eight out of the ten village muskets, and they evidently played the part of the brutal and licentious soldiery so well that elephant shikar in British territory is no longer considered worth while.

The Game Sanctuary is opened, in its turn, to elephant catching, and Kheddah operations will be allowed during 1917-18 and 1918-19, thereafter remaining closed for eight years. Like all elephants from the north bank of the Brahmaputra, the North Kamrup elephants have a reputation for hardiness, said to be due to the long distances to be travelled between feeding grounds, and the dry nature of the food; South Bank elephants are supposed to be softer on account of the grazing being more plentiful and lush.

The large spectacular Kheddahs, as run by the Mysore Government, and formerly by the Kheddah Department, are not seen here. In them more than one herd may be surrounded and retained by an army of men, while the stockade is run up, but here we build our stockades at the end of the rains, and then, when a herd has been located in the right direction, it is driven up the path on which the stockade has been erected.

In many places in Assam, salt-licks take the form of gigantic amphitheatres carved out of the hillsides and approached by narrow entrances, so that often little more needs to be done than put a gate in position to turn the lick into an economical form of elephant trap. Elephants, naturally, will not allow themselves to be driven into a blind alley like this, but a watch is kept from *machâns*, and the gate is closed on any herd that enters of its own free will.

Elephants seem to be especially fond of visiting the 'poongs' (as the Assamese call salt-licks) in February and March when the weather is hot; the earth has a purgative action. Rhino do not care very much about salt-licks, but all the other herbivora seem to appreciate them. Imperial and green pigeons are attracted in great numbers to a certain salt-lick further east in Darrang district, but it is not known what is the special attraction there. Bright sunshine is apparently necessary to extract the virtue from the earth, as the birds at once leave off pecking at the face of the cliff, if the day clouds over. The Imperial pigeons have a wallow of their own in this 'poong,' a depression filled with whitish mud, in which the birds bathe with great enjoyment.

The same country in the Sanctuary that is good for rhino is also well suited for buffaloes, and 30 years ago vast herds were to be found. Buffaloes are distinctly scarce at present, and the great diminution in their numbers is largely ascribed locally to the form of shikar employed by certain native shooting parties, who used to surround whole herds with elephants and wipe out the lot. It sounds impossible that any one could take delight in such unsavoury slaughter, but I am afraid it is true.

The Assamese believe that tigers prey heavily on buffalo herds but not so much on *mithun* (or bison). Considering the strength and ferocity of the buffalo this might appear to be incredible, but there is probably something in it. Roosevelt in his book on "African Shikar" states it as a well-known fact that lions in some places live by preference on the buffalo herds, so that there is nothing of the impossible about the more powerful tiger doing so in this country.

Not so very long ago a planter told me that when he was out one evening with a friend, they came on a herd of buff and were sitting on their elephants watching them, when suddenly a tiger came charging out of the jungle towards the herd. They each fired two barrels at him but missed, and the buff and tiger ran off. Thinking the *tamasha* was all over, the two spectators were moving off homewards when they heard a considerable disturbance in the jungle, and hastening to the spot they found that the tiger had returned to the attack and had succeeded in killing a buffalo calf. Such boldness can only be explained by supposing that it was a tigress and a very hungry one, but if a tiger can kill, as here, from a herd on the alert, it is reasonable to assume that victims can be obtained from herds off their guard.

Solitary buffalo bulls are found with the tame herds in the grass lands to the south of the Reserve, but unfortunately these are the degenerate creatures kept by the Nepalese, and the services of the wild bulls are of no value to the cows. The mother often dies on account of the calf being too big, or the calf itself, if born alive, frequently only survives a few days. It has now been proposed to exclude the Nepalese buffaloes from this piece

of country and to encourage the Assamese to bring in some of their magnificent animals, which are so nearly related to the wild stock that the breed is improved by crossing with the wild bulls: in fact, such crossing is essential if the breed, which is valuable on account of its superior milking and draught qualities, is to be maintained. Wild calves are still occasionally caught and reared by the Assamese, but increasing cultivation is rapidly removing the opportunities of obtaining wild blood in this way. According to Rowland Ward's "Records of Big Game" three species of buffalo are supposed to have been found in Assam: an extinct race, which was characterised by horns very much horizontally inclined and of great span, the ordinary, and a light-coloured species.

The justification for any such classification is obscure, and it looks as if the extinct race had been described from a few isolated specimens, and the light-coloured race from one solitary skin. Wild buffaloes with horizontally inclined horns, are occasionally killed nowadays, and tame buffaloes with horns of this type occur, *while light-coloured domestic buffaloes are so common that it must* be possible for such to occur occasionally in the wild state.

If it is safe to judge by the appearance of the domesticated stock, the wild buffalo of Burma must be a different animal from the Assam species. In the Brahmaputra valley tame buffaloes are fairly long-legged, while the horns of both the wild and the tame display a distinct backward trend before sweeping forwards to form the tips: in the Surma valley the so-called Manipuri buffaloes, which really come from Burma through Manipur, are short legged and very tubby, and the horns do not show any backward inclination at all. A selected pair of Manipuri buffaloes were sent to Calcutta for King George's inspection.

The *mithun* is found nearly everywhere in the Sanctuary, but most commonly along the foot of the Bhutan Hills. The Assamese believe that two *jats* of Mithun exist side by side—the large "Moh-Mithun" and the smaller "Goru-Mithun," but I am absolutely convinced that this is only another case of careless observation on the natives' part. I have never found any one, who could point me out a solitary bull of the small species or a

cow of the big species, and the myth has probably risen from the fact that bulls sometimes considerably exceed in size the average specimen. At any rate, a cow to match the big bull should be produced by those who want us to believe in the two *jats*.

Europeans also have a theory that there are two races living side by side. One with a dew-lap and only slight convexity of the skull between the horn bases, and the other deficient in dew-lap but with a pronounced convexity. The former species is described as being *Bos frontalis*, the origin of the Gayal or tame Mithun, and the latter as the genuine *Bos gaurus*. It is noticeable, however, that observers, as opposed to shikaris pure and simple, do not subscribe to this theory, and Stuart Baker, who went into the question very thoroughly, came to the conclusion that the peculiarities of the Gayal, notably the shape of the head and trend of the horns, were only such as might easily occur as the result of domestication. Wild Mithun, it is true, exhibit considerable differences as regards the presence or absence of a small dew-lap, shape of skull and horns, size of body, etc., but I am quite convinced, from the many opportunities I have had of studying the live animal, that all the different varieties can be found in almost any large herd. The truth is that a young wild bull, 2 or 3 years old, bears a strong resemblance in life to a typical Gayal, and the skull and horns are not dissimilar, but the differences become increasingly accentuated the older the bull. It will nearly always be found that the so-called intermediate wild heads are from youngish animals, which often attain to great bulk of body before their heads are, from a sportsman's point of view, really mature.

The Gayal is at its best in the North Cachar Hills, where wild bulls sometimes consort with the village herds, the individuals of which are larger and less docile than is the case with those living in less favoured hills. The Kukis in Manipur obtain fresh blood for their herds by purchasing bulls from the North Cachar Kukis and Nagas. In one Range in North Cachar it is quite interesting to pass through the Cachari villages, with their fine buffaloes at the foot of the hills, and then ascend to the Kuki and Naga villages with their Mithun herds, the stock in both cases

being kept up to standard by infusions of wild blood. In the Himalayan hills, north of the Brahmaputra, the wild Mithun have been exterminated by the hill tribes, and the village Mithun are consequently small and degenerate. In many cases, too, the colour has run, so to speak, and instead of the typical black bodies with white stockings, piebalds are common. The Bhutan Mithun in the country north of the Sanctuary are apparently ordinary cattle with a distant dash of Gayal blood, which comes out chiefly in the black and piebald colour and the short broad head.

The possession of Mithun is considered a sign of wealth amongst the hill people. They are not milked, but are eaten on State occasions, and are useful for purchasing brides and sacrificing at the funerals of Chiefs. The herds remain untended in the jungle during the day and return to the villages for the night of their own accord, being encouraged to do so by occasionally being given a little salt. Bulls sometimes get a trifle bad-tempered, but this is rare; one's principal objection to the Mithun is that they have a very keen nose for a stranger, and come and blow round the tents all night, if camp is pitched near a village. I was once having dinner near a Kuki village when my servant, a new man, caught sight of a Mithun as it emerged from the forest into the moonlight, just as he was going to hand me a dish; he dropped the dish with a howl and streaked for the cook-house fire, having mistaken the beast for a bear.

Hill tribes are sometimes fined so many Mithun by Government, but difficulty is experienced in disposing of the animals in the plains. They are difficult to keep alive unless free to spend their days in the forest, but planters, who have a little jungle on their estates, will take bulls to run with the coolies' cattle, and these may live a few years.

Sambhur, Swamp deer, Hog and Barking deer are all found in the Sanctuary, the Swamp deer being the most plentiful. The Sambhur is the Malayan variety, solitary in habit, with a big body and inferior antlers.

Pygmy Hog are not uncommon, and the *ordinary wild pig* exists, to divert to some extent the tigers' attentions from the more

worthy deer. The country being unridable, pig are a pest all over Assam. Guns are licensed to the villagers for the protection of their crops, but it is observed that the Hindus practically never shoot pig, which they are forbidden to eat, but reserve their powder for the deer. It is a fact, however, that deer do very little damage to the crops; they are not attracted much by ripe grain, but have a weakness for the young shoots when the upland rice first sprouts, swamp deer being the worst offenders. Deer are scared at once by a shout, but pigs, which commit havoc once the grain begins to ripen, become fearless at night unless fired at.

It is difficult to understand how Honorable Members of Council have the face to ask for the repeal of the Arms Act on the plea that the ryots' crops are being ruined, because they must know the facts.

Europeans are commonly deceived, because when they are told that "pohu" are destroying crops, they imagine that the allusion is to deer. By "pohu" a European always means a deer, but the Assamese, on the contrary, may mean anything from a porcupine to a Sambhur; the word needs to be qualified. If the complaining villager is asked what sort of "pohu" are doing the damage, he will say, nine times out of ten, that they are "Gahori pohu" or pig. Up-country men are taken in the same way. There was a great hurroosh one day, when the Brahmaputra was in flood, that a "pohu" had been washed ashore on a small wooded island opposite the town. Some Mahomedans joined in the chase and their boat was the first to reach the island, but when they found that the occupant was an angry pig instead of a mild and edible deer they started to revile the people for having said it was a deer.

Tiger and bear (Himalayan, not the sloth) are common, but leopards do not seem to find the wastes of the Reserve so attractive as the village lands elsewhere. There is no doubt that tigers are very plentiful, and permission would be given to shoot them, but it would be a poor place to come to for tiger-shooting.

Beating is absolutely out of the question on account of the thickness and continuity of the cover, while cattle and buffaloes tied up for kills are regarded more as curiosities than anything else by these well-fed tigers. There is no doubt that tigers kill

occasional rhino calves when the mother is not at hand, and also regard baby elephants as legitimate prey. In the case of the latter the tiger's aim seems to be to rush in and kill a calf, and bolt before it can be caught, as it well knows that the mother will after a time leave the dead body. I have seen an elephant that had a chronic sore back, where it had been mauled by a tiger in its young days, and knew an elephant that was found standing in the forest by her dead calf, so lacerated and weary from a struggle with a tiger, that she was unable to get away and avoid capture.

Hyaenas and *wolves* do not occur in Assam but the ubiquitous *wild dog* is a resident. It is commonly asserted that there is a big race that goes about in small packs of half-a-dozen or so, and a small race that travels in large packs. It is, also, equally commonly said that the game may be blinded by the dogs micturating on bushes, lining the paths along which it is intended to drive tne prey.

The proof or disproof of either of these theories would be difficult.

It has been suggested that the large packs appear to be made up of a small *jat* of dog because of the number of half-grown pups running with the packs, and that what are mistaken for a big *jat* are really a few mature animals that have separated from the main pack at the commencement of the breeding season.

The failure on the part of hunted deer to avoid rocks and other obstacles in their path is ascribed by some to the fact that the deer have run themselves to such a condition of numbness that they are incapable of noticing anything, but I once had a young Sambhur brought to me alive by some villagers, who said that the mother had been blinded by wild dogs and that they had caught her too, but she was too powerful for them to hold. There was, of course, no proof that she had been blinded by wild dogs, but the villagers seemed to regard it as the obvious explanation.

The wild dog has not become the pest in Assam that it is in other provinces, and I have noticed that the species most distinctly prefers the hills to the plains. I do not know if this has been observed elsewhere. Packs make periodical swoops down into the

plains, but they certainly seem to spend most of their time in the hills, even if there is less game there.

It was thought at first that a Game Sanctuary, from which European sportsmen would be excluded, would end by being nothing but a preserve for the tiger, wild dog and native poacher. Time has shown that this is not the case. So far as the tigers and wild dog are concerned, there must always be the balance, imposed by nature, between the hunters and the hunted, while the amount of poaching, detected or suspected, is not alarming. Complete immunity cannot be hoped for, and even in England, where comparatively small estates are protected by dogs and numbers of trained keepers, raids occasionally take place.

The Assam Sanctuaries will come into their own in the days, not so distant now, when communications will have improved, but opportunities for observing the habits of big game have decreased. All over the world the rifle is giving place to the camera as the stalker's weapon, and we are now waiting to welcome the photographer to our Sanctuaries.

A NOTE ON PRECAUTIONS WHICH CAN BE TAKEN WHEN TIGER-SHOOTING IN THE CENTRAL PROVINCES.

BY A. A. DUNBAR BRANDER, I.F.S.

1. The following remarks are not intended for the experienced shikari, who presumably knows what he is about and pursues his game with a tested confidence in his own abilities and a knowledge of the habits of the game he pursues. It is unnecessary, therefore, to discuss the precautions to be taken in which an unwounded tiger is deliberately followed up on foot with the intention of shooting it. Either the shikari possesses the necessary experience or he does not, but in either case his action presupposes a self-confidence that makes any remarks on the subject superfluous.

The recent and lamentable death of Mr. Bell, I.C.S., the result of following up a wounded tiger under circumstances in which the exercise of certain precautions would probably have prevented the accident, makes the present moment an appropriate one for

impressing on all who hunt tigers the necessity of taking every measure which tends to eliminate danger.

2. It will be the experience of all, however, who constantly frequent the jungle, to occasionally come across a tiger. Under these circumstances, any one with the slightest enterprise would have a shot at it, and in most the paramount idea would be to bag it, apart from merely firing.

In most cases the tiger will turn tail or bolt or attempt to slink out of sight: in such cases, there is practically no danger in firing, and a hurried or unaimed shot can be taken without serious risk, and a hurried or unaimed shot is often the only shot possible under the circumstances. There is also little danger in following up the tiger before one has fired: the intention of the tiger is to get away.

3. Occasionally, however, the tiger will assume an attitude which shows that his mentality towards the sportsman is such that he expects the latter to give way to him.

Shooting under these circumstances is attended with risks. Usually, the greatest deliberation can be taken over the shot and no hurried concern, lest the tiger should be off, need disconcert the sportsman's mind: in fact, the more careful and deliberate the aim, the more likely the death of the tiger

4. An animal when suddenly fired at at close quarters, puts itself in motion and the first rush is often in the direction in which the *body* is pointing at the time: the muscles come into play before reason controls the direction of the motion. It is advisable, therefore, when the tiger is directly facing one, to avoid firing unless one is sure of being able to kill or cripple: this rule applies equally whether the animal is aware of one's presence or not. As soon as the animal turns aside, a shot can be fired with comparatively little risk. The same applies to a tiger which is approaching in a line which will bring him past the sportsman slightly to one side: there is considerable risk in firing while the tiger is still in front. A fair balance between eagerness to shoot and safety is to allow the tiger to approach a point opposite the sportsman: further safety can be ensured by allowing the tiger to pass.

5. The number of persons who shoot tigers off elephants in these Provinces and the number of times, in which dangerous charges take place, are so few under these circumstances that no remarks on the subject are called for.

6. I cannot recollect a case in which a sportsman has been mauled when getting down out of a *machán* at night. Provided one's men can approach the tree, it is usually safe to descend and retreat with them: under circumstances other than these, the sportsman who prefers to return to camp, rather than spend a cold or hungry night in the tree, does so at his own risk.

7. The great majority of accidents occur in following up wounded tigers on foot. It is practically impossible to lay down rules which will meet all cases; so much depends on the psychology and skill of the individual and the nature of the terrain in which the hunt takes place: nevertheless, the following general principles apply. "The essence of strategy is knowledge and forethought of tactics surprise." In the hunt strategy lies with the shikari and tactics with the tiger. The precautions to be taken are chiefly aimed at the elimination of surprise. A straightforward charge with the shikari warned and prepared for it and which gets home merely indicates that the sportsman is not sufficiently skilled with his weapon for the position he has put himself into and no rules can deal with this; however, good shots and experienced shikaris can be rushed by the surprise and suddenness of the attack.

8. Some knowledge of the nature of the wound inflicted is the first information to be gathered, as it helps to indicate the likelihood of being attacked and the nature of the attack when it comes. A blind "tucked in" rush forward immediately after the shot usually means a death shot, often in the heart, and the animal drops at the end of his gallop. This must not be confused, however, with a shot through the paw or low down in the leg. In this case, after a bound or two, the tiger often gallops wildly forward and makes a very similar rush as in the case of a heart shot, but the action is not tucked up or short and the rush is not "blind": by this is meant that obstacles are avoided and a short follow up usually discloses this: an animal wounded in this way is

usually very dangerous. Large quantities of blood often indicate a superficial wound : in a dangerous wound which has penetrated the body most of the bleeding is internal. Stomach wounds show very little blood. Mere muscle wounds often show considerable blood to commence with, but rapidly dry up. Other indications of where the wound has been inflicted are pieces of bone, intestine, or liver ; froth and blood indicate a lung wound. Blood on each side of the trail shows that the bullet has passed through the animal and the position of the blood on grass indicates the height of the wound. A tiger, whose back has been broken, is practically helpless ; nevertheless, it is a golden rule to look upon any tiger, which shows the slightest signs of life, as a highly dangerous animal and lead should be poured into it until all signs of animation have ceased, and this rule cannot be too strongly impressed on the sportsman, who often has an opportunity of doing so when still in his *machán* but hesitates out of consideration for the skin and which he may risk his life to procure subsequently. It is a fairly common occurrence to see a tiger's tail waving perpendicularly in the air, the tiger being stationary at the time. I have never known this not to be a sure sign of death. A wounded animal may be dangerous to follow up by reason of the wound being so severe as to make it almost certain that he will not try and escape, in spite of the fact that such a wound probably cripples him to some extent in his charge : on the other hand, the wound, if permitting the animal to make strenuous efforts to escape, will be no hindrance to his charge when it comes. The following is probably the "order of danger" with relation to the wound inflicted :—

(*a*) A stomach wound : it usually makes the tiger very angry and is no impediment.

(*b*) A shot through the paw or a broken leg low down : the nature of the wound makes him disinclined to escape and it has surprisingly little effect on the speed of a short rush.

(*c*) A muscle wound : the tiger is often very little affected, and it does not make him nearly so angry as in the case of a stomach wound.

(*d*) A shot in the liver: practically no impediment to the charge, but the tiger is drowsy and disinclined to move: given time, he will die.

(*e*) A shot which has shattered one of the limbs high up: such a wound is usually a serious impediment to the charge.

(*f*) A lung shot: the tiger is very disinclined to move and avoids going up hill.

(*g*) A broken back: the tiger is practically helpless.

It is unusual to have wounds (*e*) and (*f*) inflicted without their at the same time being deadly, although death may not immediately supervene. It is always a wise precaution, therefore, to wait some time before following up, but here again we are up against the temperament of the hunter, whose actions will be directed by the strongest impulses and increased danger will often be less intolerable than the anxiety and irritability induced by waiting.

9. Most tigers shot in the Central Provinces are killed from *machâns*, either by sitting up, or in beats.

In the former case and supposing the animal to have got away wounded—and we will assume it is getting dusk or even dark—the wisest course is to come away at once and postpone the hunt till next morning. It is very probable the tiger may have died. If the tiger has gone some distance to find water, he is probably not mortally wounded and he is very likely to be found in the vicinity of the water, which should be approached with extreme caution and from above, giving special attention to all dense cover in the vicinity. A good plan is to surround a considerable area round the water with men on trees and gradually contract the ring. The tiger is almost sure to be sighted and can be killed with comparative safety. If the tiger has made no attempt to reach water, he is very severely wounded and is probably dying. He will be very disinclined to move and will not tolerate being shifted far, in fact he will often only shift once. The above remarks only deal with the special conditions arising out of the fact that the tiger has been wounded some 12 hours previous to being followed up.

Most of the precautions enjoined in the succeeding paragraph, however, are equally applicable.

10. We will assume that a tiger has come out in a beat, been *wounded and gone through*, a very common occurrence in these Provinces.

If men can be trusted and spared, it is a great convenience to have three or four posted in trees as markers well behind the beat, say at intervals of 100 yards. They can generally give one most valuable information: the tiger may have lain down before it reached them, they may have seen it die or lie up, in which case it can often be at once surrounded by men in trees and shot from a tree with safety. If the tiger has not reached the markers, then the area between them and the *machán* can be similarly surrounded. If the tiger has gone past the markers, some information regarding the nature of the wound can generally be given.

11. Assuming that the latter eventuality has taken place, and that a long and strenuous hunt is before the shikari, I propose to indicate the average difficulties that will be encountered and the general precautions to be taken. The hunter must bear in mind that his primary object is to locate his tiger, not merely to come up with it. if the latter alone be his object, it either results in the tiger escaping or being killed with the maximum risk to the hunter. By locating the tiger is meant that it is known to be inside a particular patch of jungle which is so surrounded that it cannot move away without being seen This stage should be reached, if possible, before any attempt is made to kill it. When hunted, tigers naturally lie up in cover and avoid the open, but cover is a relative term, and consists of nalas, jungle, rocks, grass or any combination of these four—in fact, any spot which is more "concealing" than the general average of the surrounding country. Such spots, therefore, should be approached with extreme caution, a position should be taken up which gives the hunter an advantage, *i.e,* beside a stout tree or on an eminence : the cover should then be stoned before advancing, a stone landed near the tiger will produce a growl or he will slink off or he may charge : in the latter case, the shikari is prepared. In thus following up a tiger, only 3 or 4 men,

whom one can control and more or less trust, should be taken. More than this are a nuisance and a source of danger: a considerable body of men can be brought on quietly some hundreds of yards in the rear, as their co-operation will probably be required later on. The sportsman should not attempt to track himself, he should quarter the ground slightly in advance of the trackers and his duties are to defend and protect all concerned from unnecessary risks. Strict silence should be enjoined so as to give one every chance of hearing the tiger. It may be here as well to mention that such a hunt usually commences with great caution: during the first hour every precaution known to the hunter is taken and every sense is fully exercised—not only exercised but stretched to the utmost limit—until nervous exhaustion supervenes, precautions are reduced and the trail is followed with an indifference that was unthinkable in the first few hundred yards. The hunter is, therefore, warned to guard against this by conscious effort.

12. To return to the hunt, however, assuming that blood and flattened grass show that the tiger had lain down and has been moved: it is necessary to approach the next cover with extreme caution: most tigers will move once but many will refuse to move more than once; much depends on the nature of the wound. If the cover towards which the tiger has moved is good and the wounds indicate that he is not likely to have gone far, some men should be called up and the area circled before proceeding. It is impossible to give all the *pros* and *cons* which would decide a hunter to apply this process to a particular patch of jungle, but these are often fairly clearly indicated if it is borne in mind that the object is to locate one's tiger before attempting to kill him.

A tigress is more likely to demonstrate and is more easily moved or turned than a tiger; a tiger, if he has once demonstrated, is more likely to charge and charge home, than a tigress.

13. Assuming that one has located one's tiger, the men should circle the area in trees and the circle should be gradually contracted on the safest sides. The shikari can then climb a tree on the side the tiger is most likely to move to and men can stone the jungle from the other side. If one does not see the tiger oneself, some one

else does, and, as soon as the tiger lies down, the man who sees him can be joined. This is the safest and simplest method of finishing off a wounded tiger. The most difficult terrain in which to carry out this operation is flat country, with a dead level of cover, but such areas are happily not very common.

14. Great caution should be taken in crossing a nala, the tiger often lies down on the top of the opposite bank which should be well stoned before descending to the bottom. Do not follow the trail along the bottom of the nala, keep along the top and let the men spoor along the bottom behind: the tiger is not likely to be in the bottom of the nala, unless it is a steep narrow straight cut nala, generally of the alluvial type. In this case, one may come on him suddenly round a bend; one should keep, therefore, to the top of the nala on the opposite side to that on which he is likely to be and somewhat ahead of one's men.

15. Hills, especially steep hills, "take it out of" wounded animals. A tiger that is going to die shortly will not go up a steep hill. A wounded animal is very apt to lie down on the face of a hill as it tires him or, if it is a short hill, just on the edge of the top. A tiger is much more likely to charge down hill than up, and when he does so he is much more difficult to stop. Never follow up a blood spoor up a steep hill or ravine side. Put some men in trees at the bottom as markers, go round and come down from above stoning your ground in front of you. One can often shoot the tiger with comparative safety from above or he can be driven into the bottom of the ravine and located, and if he charges he is fairly easy to stop and the sportsman is steady by reason of the confidence his superior position gives him.

16. Few tigers will seize a man in their stride; if the man stands still, they pull up dead at his feet and then proceed to bite and claw; in a charge, therefore, stand still, there is nothing so fatal as to move and it often results in a fall. Reserve one's shots, especially the second barrel, until the last moment.

17. Buffaloes are sometimes used in hunting wounded tigers It is a process, however, which is attended with considerable risks to all concerned. The tiger is apt to work round the ends of

the herd and seize the herdsmen who operate on the flanks and the animals get so excited they are quite likely to charge the shikari. Their use is, therefore, only advocated in certain circumstances. Assuming that one has located one's tiger, but, by reason of lack of trees or the density of the cover (such as is often found in frost hollows full of tall grass), it is found impossible to shift or sight him and to enter the cover would be practically to commit suicide, buffaloes or even cattle can be employed with effect. They should be rushed into the cover without giving them much time for deliberation; in fact, this is the only method possible with cattle. The tiger may shift and may be shot while doing so, or he will spring on the back of an animal, when the sportsman has to run in and shoot him. Where the necessity of employing this method arises, the sportsman is warned that he is undertaking a highly dangerous performance.

18. A concluding word may be said on weapons. These should consist of the heaviest double-barrelled rifle the sportsman can conveniently handle, and, if a tiger has been wounded with a small bore, the arrival of a heavy weapon should be awaited before any attempt at following up is made.

Summary of rules and precautions to be taken so as to reduce risks in tiger-shooting.

Shooting on foot.

1. Avoid firing at a tiger whose body is directed towards you, unless you are sure of your aim: as a precaution, allow him to turn to one side.

2. If the tiger is coming towards you, unless sure of your aim, allow him to get to one side, or even past, before firing.

Sitting up over a kill.

3. At night, if the demonstrations of a tiger prevent one's men coming to the foot of the tree, the sportsman who descends and returns to camp does so at his own risk.

4. A tiger which has been wounded overnight and has gone any distance to water will probably not die and is probably near the water.

5. A tiger which has been wounded overnight and has made no attempt to reach water, is probably mortally wounded. He will not tolerate being shifted much.

General.

6. Most accidents occur through surprise attacks.

7. In following up a wounded tiger, let the shikari have as his object the locating and surrounding of the tiger before attempting to kill it.

8. Do not follow blindly along the trail with the chance of stumbling on to it: the tiger will move away until he makes up his mind to make his own attack at his own moment.

9. Wounded tigers lie up in cover which consists of nalas, jungle, rock, grass, or any combinations of these four: in fact, any spot which is more concealing than the general average of the surrounding country.

10. Approach all cover with caution and stone it before entering it, taking up a position of advantage beforehand.

11. A wounded tiger cannot be moved indefinitely from cover to cover: sooner or later, he will turn.

12. A tigress will shift more often and more easily than a tiger and is less inclined to charge home.

13. All tigers charge down hill much more readily than up and are much more difficult to stop when doing so.

14. Look upon all tigers, which show the slightest signs of animation, as dangerous animals and continue firing until all such signs have ceased.

15. All wounded tigers are dangerous; more so, according as the wound is situated in the stomach, low down in a limb, a flesh wound, the liver; less so, high up in a limb, the lungs, the back.

16. In following up a wounded tiger study all indications, which show the nature of the wound.

17. Do not attempt to gather a wounded tiger at night or at dusk: wait till next day.

18. If charged, stand still and reserve fire to the last moment, especially the second barrel.

Beats.

19. When a tiger comes out, remember general rule 14 and thus, if possible, avoid a dangerous follow up.

20. If trustworthy men can be spared, have 3 or 4 men in trees, at intervals of 100 yards behind, to act as markers.

21. If there is time to do so and your temperament permits, delay some time before following up.

Following up wounded tiger after the beat.

22. Select 3 or 4 of the best men only to accompany you. Others can follow at a distance behind Insist on silence.

23. Do not attempt to track yourself, look out for the tiger instead.

24. Remember the general rules, especially 7, 8, 9, 10, 11, 12, 15, 16 and 18, as they will almost all be applicable.

25. If the tiger growls or shows up in any way, put a man up a tree, he can often see it and can be joined.

26. If the tiger has been located or there is a strong probability that he is in a particular cover, surround it with men in trees, get into a tree covering the most likely break and have it stoned out from the safest side Men can advance, with comparative safety, from tree to tree, after stoning, provided some remain up as markers.

27. Stone the opposite side of a nala before crossing.

28. Do not follow a trail down the bottom of a nala, stick to the edge of the bank opposite the tiger and in advance of the trackers.

29. Never follow a wounded tiger up a steep hill or ravine side. Put men in trees at the bottom, go round and come down from above. (See general rule 13.)

30. Be particularly on your guard against relaxing precau tions after the hunt has proceeded some time and exhaustion has set in.

31. Use buffaloes or cattle to drive out a tiger located in otherwise impossible cover.

RAISING SEEDLINGS OF TIMBER TREES IN GREAT BRITAIN.

The following note addressed recently by Lord Barnard to the members of the Surveyors Institution may be of interest:—

Lord Selborne states:—"The increasingly heavy demands "which the war is making on our timber will necessitate a great "amount of planting later on. Nurserymen are suffering severely "from the shortage of labour, and it is likely that after the war "their stocks of plants will be smaller than usual. The seedlings "may easily be raised; and I hope that a number of members of "your Society will take the matter up.

"I enclose a list of the species which we think are likely to be "in most demand after the war.

"It would, I think, be well to impress on members of the "Society the usefulness of even small sowings, for in the aggregate "a large number of seedlings might result."

The list referred to is as follows:—

Larch	Sitka Spruce	Douglas Fir	Corsican Pine
Common Spruce	Scots Pine	Silver Fir	Beech.

EMPLOYMENT OF CANADIANS ON FOREST WORK IN GREAT BRITAIN.

"Several hundred men have already joined the ranks of the Forestry Battalion of 1,500 men, now being organised in Canada at the request of the War Office for special work in Europe. It is expected that the full complement will be ready shortly, after a brief training at Petawawa, to proceed to England."

A correspondent forwards the above cutting from the *Times*' Weekly Edition of April 28th, 1916, and suggests that the activities of the Canadians referred to would probably not be confined to fighting but they might be also engaged on State Forestry in Great Britain.

The correctness of this supposition is confirmed by the following extract from *American Forestry* for April 1916:—

"Timber is becoming so scarce in England and high freights and scarcity of ships have rendered the situation so acute that the War Office has asked the Canadian Government to enlist a battalion of woodsmen to cut timber in England. Recruiting will start at once. Lieutenant-Colonel Alex. McDougall of Ottawa will be in command."

EXTRACTS.

AFFORESTATION IN SCOTLAND.

Development urged upon Government.

The Royal Scottish Arboricultural Society have sent the following statement and resolution on the subject of the development of afforestation in Scotland, to His Majesty's Ministers and all the Scottish members of Parliament:—

The Council considering:—

1. That for many years the Society has been urging upon Government the necessity for adopting measures to promote afforestation in this country;

2. That all our home experts in Forestry, and such of the oversea experts as have visited this country, including the eight distinguished foresters who represented the leading Continental, Indian, and Dominion forest services at the Society's diamond jubilee celebrations in 1914, have unanimously expressed the opinion that Scotland lends itself admirably to afforestation on a large scale, and that Government ought to give the movement the support necessary to bring this about;

3. That in recent years successive secretaries for Scotland have promised on behalf of Government that a Department of Forestry would be created in connection with the Board of Agriculture for Scotland, but that such Department has not yet been formed;

4. That the Board of Agriculture for Scotland and the Development Commissioners have failed to make reasonable provision out of the funds under their control for the development of forestry in Scotland, and that it is therefore necessary that the new Department of Forestry, when formed, should be provided with a separate annual grant adequate for this purpose;

5. That the area of woodlands in Scotland previous to the war was about 868,000 acres, or only about 4 per cent. of the whole land area, being the lowest percentage of the countries of Europe

(except Ireland and Portugal), and forming a striking contrast to other countries on the Continent having from 17 up to as high as 53 per cent. of woodlands;

6. That the annual value of the imports of timber into the British Isles previous to the war was about £40,000,000; that between 80 and 90 per cent. of the timber so imported consisted of coniferous or soft woods of which a large proportion could have been grown in this country, and if so grown would have provided healthy and remunerative occupation for a large rural population, and have prevented the present timber famine and the great shortage of tonnage from which the country is now suffering:

7. That the war in which the country is at present engaged has directed particular attention to—

(1) the dependence of this country on foreign countries for timber of all kinds, but especially pitwood and railway timber,

(2) the greatly increased demand for all kinds of home-grown timber, which, owing to the widespread devastation on the Continent, is likely to continue long after the conclusion of the war,

(3) the large areas of home woods that are being cleared to meet that demand, including young, thriving plantations, prematurely cut for pitwood, for which they were not intended,

(4) the improbability that all, or even a large proportion, of these areas will be voluntarily replanted, with the result that the already relatively small extent of woods in this country will be alarmingly decreased,

(5) the very large areas of comparatively poor land in the country which would be more economically used in growing timber crops than as at present used,

8. That during their various excursions abroad the members of the Society were much impressed with what had been successfully done by the various Continental countries visited in combining schemes of small holdings with afforestation, to the great advantage of both;

9. That afforestation not only provides employment for a considerable population at the outset, but ultimately for a very large population in connection with subsidiary industries such as saw-milling, wood-working, and other rural industries,

10. That at the close of the war a large number of men will be returning home who may not be able to resume their former occupations, and would prefer to settle upon the land if they could be assured of a healthy outdoor life and a comfortable home and that the return of such men will form a peculiarly suitable opportunity for making a beginning with the afforestation schemes which are so necessary to provide timber for our national requirements.

Resolved—That it is necessary, in order to provide for the nation's future requirements of coniferous timber and such hardwood timber as can be economically grown in this country, and also to afford suitable and healthy employment for a large and ever-increasing rural population, that Government should now create the promised Department of Forestry in connection with the Board of Agriculture for the development of forestry in Scotland, with an adequate annual grant for the purpose, and should instruct the Department to prepare, without delay, schemes of afforestation, combined with small holdings and other rural industries, to be put into operation as soon as the war is over, so that advantage may be taken of the unique opportunity when returning soldiers, sailors, and others are desiring work, to induce a proportion of them to settle on the land by offering them immediate and suitable employment in comfortable and congenial surroundings.—[*Timber Trades Journal.*]

FORESTRY IN AUSTRALIA.

The recent conference of Federal and State representatives in Melbourne unanimously carried a resolution approving the establishment of a central school of forestry by the Commonwealth and the States, and also that a special training school of tropical forestry should be instituted. The subject of forestry is one that is attracting increasing attention throughout Australia, and all the States are

giving it serious attention, though so far small practical results have been achieved. The Minister for Lands of New South Wales has announced his intention of submitting to his Cabinet definite forestry proposals, and he states that very shortly three million acres of State forests will be allocated. It will be the duty of the Forestry Department to conserve the timber interests of the States, upon approved lines, ensuring the cutting down of only matured timber and planting fresh forests. [*Timber Trades Journal.*]

THE LIGHTEST WOOD.

Balsa (*Ochroma lagopus*) is a tropical American tree having a very soft wood that the Missouri Botanical Garden has shown is only about half as heavy as cork.

This wood is being used in life-rafts, life-belts, and for buoys of various kinds, and is claimed to be preferable to cork in other respects as well as in lightness.—[*Capital.*]

BIRD'S-EYE MAPLE.

The cause of bird's-eye figure so familiar in maple wood has been a source of much speculation............*American Forestry* shows that the phenomenon is produced by adventitious buds, which have their origin under the bark, and may begin to develop when the tree is quite small. These buds, though they may live many years or die and be replaced by others, are rarely able to force their way through the bark to become branches. The Japanese are said to produce artificial bird's-eye growth by inserting buds beneath the bark, a sample of the artificially produced bird's-eye wood being in the Field Museum, Chicago.—[*Capital.*]

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NOTES ON THE PROSPECT OF WORKING THE HARD-WOOD FORESTS OF BURMA.

The following article, contributed by Mr. H. R. MacMillan, Chief Forester in British Columbia, will be read with interest by Indian Forest Officers and more especially by those in Burma :—

A visitor, particularly from a temperate climate, should be cautious in expressing an opinion on forestry in India. The difficulties under which the work is carried on are obviously beyond his imagination. Therefore, though the writer's conviction that India is a full half century or more ahead of North American forest administration, is expressed on a mid-March noon in camp in a Burma jungle, it does not follow that he feels himself capable of properly appreciating the fight won against climate, exile, subordinate inertia and apathy before results began to appear.

The Forest Service in India is fortunate in having courageously secured complete control of the forest resources of the country. This advantage may not be fully realised by those foresters who

have not seen what has happened in the United States and Canada, where unregulated exploitation has destroyed rich virgin forests, with small return to the Government and small profit to the timber-cutters, and has left, in the place of the forest, land unfit for agriculture, upon which the regeneration of a useful or valuable forest will be a slow and expensive process—so expensive in the case of large areas in Eastern Canada that there is no prospect of its probable accomplishment. Only limited proportions of the forest land, either in the United States or in Canada, are under the management of the Forest Services. North American foresters must yet struggle for generations towards the position already held by the Indian Forest Service, *viz.*, the control of all the forest land in the country and the freedom to manage it for the benefit of the State unaffected by little else than yield, market and sylvicultural considerations. It is marvellous that in a land so old as India, the Forest Service should, unhampered by private opposition, administer practically all the forests, and that in a country so new as America, private owners should, unhampered by Forest Services, destroy so much of the forest. It speaks volumes both for the skill and vision with which the early Indian foresters assumed control of the situation and for the destructive tendencies of the Anglo-Saxon immigrants to the new world.

Forestry in India has succeeded in hiding its light under a bushel. The propaganda, which it is necessary to carry on in North America to secure public support and appropriations for forest work, results in all work being widely advertised, sometimes to such an extent that the actual accomplishments when viewed are disappointing. It is refreshing to find that in India the reverse is true, that forest administration is in advance of the accounts that have been allowed to penetrate to other countries.

It is surprising to find that so little cutting is done in reserved forests in India except according to Working Plans which provide for the maintenance of the annual yield. Canada has yet to initiate her first Working Plan, though there are many places, east of the Rocky Mountains, where over cutting is the rule and

where conditions of market and accessibility make Working Plans already desirable. The situation in the United States is not greatly different. East of the Rocky Mountains practically the whole of the valuable hardwood and pine forests are being wiped out by uncontrolled cutting. Both forest and land have passed beyond the control of Government. West of the Rocky Mountains where the greater part of the United States forest reserves are situated, over two-thirds of the forests have passed into private ownership and are being cut as they become accessible, without regard for any consideration excepting present profit. The forest reservations do not contain the richest nor most accessible bodies of timbers, excepting in a few instances, and there has not yet been such a tendency to over-cut as would be the case with valuable species in Indian forests were no control imposed Though it has not yet been found practicable nor advisable, for a variety of reasons, to undertake the preparation of Working Plans on a large scale, the United States Forest Service in administering the western forest reservations is keeping the annual cut from each reservation below the possibility of maintained production and is seeking, chiefly by adapting cutting methods to the sylvicultural demands of the valuable species, to secure natural regeneration. A great difficulty in the way of forest administration both in Western Canada and in the Western United States is the unprofitable nature of the timber industry, a condition which seems likely to continue, through the ruinous competition induced by over-production of timber and is likely to render any forest regulations, however slight the extra expense they entail, difficult of introduction.

The profits possible and evidently common to the teak industry in Burma are astounding, and incredible to one acquainted with the timber industry in North America. A country where private companies can clear a net profit of 35 rupees a ton on so simple an operation as moving logs one hundred or two hundred miles from a Government surveyed and counted forest to an assured market would seem an earthly paradise to the loggers and timber dealers of Western Canada, where firms build costly railroads into

country which they have explored at their own care and charge, risk their logs two hundred miles in the open ocean, erect their own mills, drying kilns, extensive lumber yards for the manufacture of eight or ten species of timbers into the forty or fifty dimensions and grades in which they must be stocked and put on the market, and in the end, after granting six months to two years' credit on the sales, reap a net profit of two to three rupees a ton.

The situation viewed from the Government standpoint is quite as astounding. One might almost say, so valuable is teak, that the management of this timber resembles a mining operation almost as much as a forestry operation. The profits accruing to the Government on a tree which nets 30 rupees a ton in royalty, or 70 rupees a ton in profit on departmental working, are so great, that even should there only be one or two trees per acre the forester, led like the placer miner of early British Columbia, by the beacon of easy gold, is tempted to manage his forest for teak alone, or nearly so, although the remaining nine-tenths of the forest may consist of useful and probably valuable species of large size, free from log defects and comparatively easy of access. That teak alone should float, that coincident with teak should be that rare, cheap and self-propelling skidder, the elephant, has, together with the great profit possible on teak, made the apparent neglect of the other species natural.

A forester, somewhat familiar with the world's timber markets, and likewise with the quality, condition and cost of production of hardwood timbers, in the regions from which the chief hardwood supplies of the world are now being drawn, may perhaps be pardoned, for venturing to suggest that possibly the time has come when the undeniably rich hardwood forests of Burma might be worked, to the advantage of sylviculture, at greater profit than is afforded by the present extraction of teak alone.

A reference to the history of the hardwood forests of North America reveals the fact that originally those forests were considered in somewhat the same light as the hardwood forests of Burma to-day. Two generations ago the southern portions of

Eastern Canada were covered with a dense forest of mixed hardwoods, amongst which and beyond which lay stands of the valuable white pine (*Pinus strobus*). White pine was floatable, was in great demand and the cutting of it for export to Europe was the staple industry of the community. The hardwood forest, containing on an average perhaps twenty-five to thirty tons of timber to the acre, consisting of a mixture varying from about eight to over thirty species, practically none of which would float, was considered a menace to the development of the community. One or two hardwood species, white oak (*Quercus alba*) suitable for the navy of the day and for tight cooperage, and black walnut (*Juglans nigra*), valuable for cabinet work, were extracted. The remainder, other oaks, elms, maples, beech, birch, ash, hickory were by dint of great exertion cut down, turned into potash for export or burned without salvage. Only when destruction was almost complete, thirty years ago, was it discovered that not one of those woods was without its value in the implement, vehicle, furniture, house trimming, general manufacturing and pulp industries that had sprung up in the country. Within a few years after completing the destruction of her hardwood forests, Canada was importing, for her industrial needs, mixed hardwood timber at the rate of over £4000,000 per year. The Canadian hardwoods were destroyed because white pine being a floatable wood was more easily and more profitably extracted and marketed, while the hardwoods being mixed and accessible only by railroad appeared to involve a greater risk and greater effort—an effort that was not forthcoming while white pine was available.

It was proved beyond a doubt, however, when a start was made with the extraction of the mixed hardwoods, that a use and market could be found for all species at a certain profit. The difficulty very quickly became one of forest exhaustion. The parallel between the situation now existing in Burma and the condition two generations ago in Canada is striking.

The objections urged against the extraction of the hardwoods of Burma are, roughly—

(1) the woods will not float and are therefore inaccessible;

(2) the species are low in quality and unmarketable;

(3) the forest is so mixed that the bringing together of saleable quantities of uniform timber is hopeless.

There may be many areas in (the great hardwood region of) Burma that are inaccessible because the timber will not float, but there are large areas (such as those visited by the writer in the Tharrawaddy Division) where the mixed hardwood forest is incomparably more accessible to the ocean than the greater part of the hardwood forests in America, from which a great portion of the world's supplies are now being drawn. Accessibility of a hardwood forest depends upon the area of the tract, the quantity of timber that may be cut from an acre, the topography and the distance of the tract from an existing railroad or port. The area must be large enough to produce, under the conditions under which it is to be cut, timber sufficient to supply a railroad and saw-mill for fifteen to twenty years. There must be sufficient timber cut per square mile or per acre under the regulations imposed, to permit of the concentration of the extracting operations to such an extent that it will not be necessary to drag the logs too far to the railroad nor to build an excessive mileage of railroad branch lines. The topography of the country, while not necessarily level, should admit of the reaching of the whole area by cheaply constructed light railroad branches about four miles apart. The various factors named are, of course, interpendent, a saving on one charge makes possible a greater expenditure on another, and the combined charges, when compared with the cost of building the railroad necessary to connect the tract with existing communications, and the value of the timber at the point of sale, determine the feasibility of railroad logging.

While it is not possible to attach concrete values to the factors to be considered, it may be stated without hesitation that at least one tract visited in Tharrawaddy meets the requirements in every particular. This tract of about sixty square miles, if cut under the system now being tried for the introduction of the Uniform method, should produce at least fifteen to twenty tons of marketable timber per acre from the present stand. Hardwood forests averaging

about this stand per acre, and no more accessibly situated are profitably extracted by railroad in America. The cost of making the logs and hauling them to the railroad on this particular tract in Tharrawaddy would come to about four rupees per ton for an average haul of two miles. This is on the average cheaper than would be the case for an American logging operation. The construction of the logging railroad to the main line railroad, about fifteen miles, and the construction of the branch lines probably at the rate of one to three miles per year, would involve no difficulties and no expensive work. The ground traversed appears much more adapted to cheap railroad construction, an inexpensive operation, than is usually the case in hardwood tracts now being logged in America. It should be kept constantly in mind that no gauge less than a metre should be used for such timbers as the heavy hardwoods, that the loads will all travel one way, from the hills to the plain and that, therefore, down grade curves to 4 per cent. are permissible, that the standard of construction should be kept as low as is consistent with economical operation in order to avoid piling up overhead charges. The capital cost of the line should be kept low even if a slight increase in the operating charges is involved. This is important for the reason that if the tract is worked over in twenty years, not to be touched again until the end of another rotation, the capital cost of the railroad should be entirely wiped off during the period of working.

Though an accurate estimate of the quantity of timber on the tract is not available and an estimate of the cost of construction of the railroad has not been made, judging from results obtained under similar or less favourable conditions in America, it is safe to hazard the estimate that hardwood timber from the Tharrawaddy Division may be delivered over a railroad twenty miles long, to Letpadan, for ten rupees per ton exclusive of royalty. Under such conditions the hardwood forests can no longer be held to be inaccessible. Were these forests, just as they stand, situated in North America, keen competition would arise for their purchase, they would be logged by railroad, and a portion of their outturn would be sold in Europe, Africa and India.

The prevailing belief that mixed Burma hardwoods cannot be sold appears to be due to several causes, the most important of which are :—

(1) most of the woods, if used in Burma, are destroyed by white-ants ;

(2) competition in foreign markets with established American hardwoods ,

(3) the conservatism of timber dealers ;

(4) seasoning difficulties have not been solved ;

(5) the timber has not been put on the market in sufficient quantity ;

(6) the possible selling price is unknown.

If some of the most valued American woods had made their debut in Burma, they would have been quickly destroyed by white-ants and would have earned an unsavoury reputation which would have delayed their introduction to foreign markets. Possibly Burmese woods, which are lightly valued in Burma, both because they suffer in comparison with the extraordinarily valuable teak, and because they do not resist white-ants, would, nevertheless, meet some of the many varied requirements of foreign markets. The hardwoods in the Burma forests will produce, on the average, longer, cleaner, sounder logs than the present American hardwood forest, and will evidently furnish woods of almost any desired hardness, colour, weight, durability, strength or quality. The chief foreign markets of the world are now dominated by supplies from the United States. American oaks, maple, birch, poplar, elm, beech, gum are exported to Europe, Canada, Africa, Australia and even to India, in large quantities. The demands of the domestic market in the United States are very great and are rapidly growing, the area of hardwood forest remaining is small, the quality of the timber remaining shows deterioration, the price is increasing and the supply available is expected to last, at present rates of consumption, only a decade or two.

The United States cannot continue to export, in large quantities, the species now well known in Europe, nor are there other species that can be substituted from that Continent. The time

appears opportune, when trade becomes normal, to put new hardwood species on the foreign market.

A difficulty to be overcome is the conservatism of the timber trade. Timber is bought and sold in importing countries on name alone. Neither the wholesaler, the retailer nor the ultimate consumer have any means of testing timbers except by trial. Once they discover that timber with a certain name is suitable for a fixed purpose, they demand that timber and depend upon it so long as it is available at a reasonable price. This is particularly the case with hardwoods used chiefly as raw materials by manufacturers. Every new hardwood has, therefore, had a stiff fight. It has only entered the market when the timber originally in demand became too expensive. The marketing of American hardwoods abroad during the past three decades exemplifies this condition. Almost every timber-using trade in Great Britain, though built up by the use of certain American hardwood species, has seen the species originally used become expensive and suffer substitution or dilution by timbers previously considered unfit. While white oak abounded other oaks were considered unsuitable for industrial purposes. The latter now constitute the bulk of the exports. The tight cooperage industry was built up on *Quercus alba*; it is now supplied chiefly by other species. The slack cooperage industry depended originally on basswood (*Tilia Americana*). This species became valuable and so species previously left to rot in the forest, gums, beech, poplar, now constitute the raw material of this important industry. So it goes throughout the hundreds of trades and industrial establishments using hardwoods, all have within a generation been forced, against their will, to accept new timbers, sometimes new species of the same genera, sometimes woods different in family as well as name, yet upon investigation proving, while different possibly in appearance, to possess the characteristics demanded by the industry. Maple and oak have been substituted for hickory for use in handles. Gums under the names of Satin walnut and Circassian walnut have been substituted for genuine walnut in the furniture and cabinet trades; gum, under the name of hazel pine, has been substituted foe more valuable hardwoods in manufacturing office fittings. Thr

Japanese, in endeavouring to build up an export trade in hardwoods to the west coast of North and South America, and India, are giving their timbers trade names such as Hakaido pine, Japanese ash, Japanese oak, to indicate the uses to which they may be put, though they may be quite different from the woods after which they are named and with which they compete; this is a wise precaution in order to secure for the wood an easy introduction to the market After the wood has been supplied to the proper industries at a competitive price, it will be purchased on its own merits. The fact that various families, genera and species have followed one another in maintaining the hardwoods required by the industrial world shows that Burmese hardwoods need not be ruled out merely because they differ in name and minor characteristics from the species now in use. Vehicles, furniture, small woodenware, implements, cooperage, packing cases, machinery and other industries will continue to demand woods of almost every combination of hardness, toughness, durability, strength, cleavability and finish. No one of the four or five score widely varying species from the forests of North America has been found unmarketable. An industrial use and profitable demand has been discovered for all. The same will undoubtedly prove the case for Burmese woods.

Hardwoods vary greatly in their seasoning characteristics. Those which warp or split when seasoned naturally in the open or which develop moulds will require special treatment. This is especially likely in Burma, where the climate will induce too rapid drying and at certain seasons a very rapid growth of fungi. It may be expected that experimenting with gradual seasoning by steam in dry kilns will prevent warping or splitting with most species, and that dipping in inexpensive aseptic solutions will prevent the development of stains in others. Such problems have been so successfully solved with troublesome hardwoods elsewhere as to lead one to expect favourable results when they are taken up in Burma.

Even when other hardwoods were selling at good prices in the United States fifteen years ago, red gum was left standing where

mixed forests were cut, solely because it could not be seasoned by the open-air methods then in use for other species. The seasoning of this timber was investigated by the Forest Service, a simple and inexpensive system was devised, which prevented warping or splitting. As a result, the wood is now in great demand for furniture, cabinet work, cooperage and industrial purposes. Excellent results may be expected from studies of the methods to be adopted in seasoning the hardwoods of Burma. These hardwoods, it once sufficiently seasoned for shipment, will not exhibit the same tendency in temperate climates to check, split or warp as if used in Burma. The problem of seasoning the product from a mixed hardwood forest is of course greatly simplified if sufficient quantities of each of the various classes of species are brought to a common centre each year to make economical handling possible. This would be the case where railroad logging operations were in progress.

A vital point in marketing new or unknown timbers is the maintenance of a constant supply on the market. There is nothing gained by sending a new product to market in wheelbarrow loads. A new species may be eminently suitable for vehicle manufacture; a few logs are sent to a manufacturer in England for trial; the wood is found satisfactory; the manufacturer or timber importer enquires the price at which several *hundred tons a year can be delivered at an English port;* an answer is not forthcoming and the business drops and yet the difficulty may not have been in the quantity of the particular timber available in the forest. Several species likely to be valuable are more plentiful in the forests of Burma than any hardwood species in the United States Several useful species now standing unused are probably quite as plentiful as teak. The difficulty lies in the fact that these species are not now being taken out in commercial quantities. If one or two thousand acres of hardwood forests were cut over in one felling series each year, a sufficient quantity of the various timbers suitable for the various trades would be accumulated each year to interest the importers and to develop an export demand.

Once a supply of a few thousand tons of each of the various classes of timber, suitable for such industries as vehicle building, machinery, implement, handle, furniture or cabinet-making, is assured each year, it should prove easily possible to make sales. It is manifestly impossible, however, to develop a market either when only a few logs of a species can be secured at odd times, as at present, or where one species alone must bear the whole cost of making the roads, and improvements for extraction, as is now the case with pyinkado.

Burmese hardwood timber can be placed upon the different foreign markets, if extracted and manufactured in the same manner as in the United States, at lower prices than were demanded for American hardwoods before the war. There is not sufficient space here to enter into detailed comparisons of cost, but it is safe to estimate that converted Burmese hardwoods can be placed on the British market, in times of normal freights, including an average royalty to the Government of seven rupees a ton, for seventy-five rupees a ton. The freedom of Burmese hardwoods from knots, decay and defects will make possible the production of a very high grade of timber such as cannot now be secured in American species on the English market for less than eighty to one hundred rupees per ton.

The organisation which will make it possible to sell Burmese hardwood timbers at competitive prices on foreign markets will also make it possible to get over the difficulty, hitherto insurmountable, of assembling at one shipping point a sufficient quantity of each of the various classes of timber to make it possible to work up a market for the complete produce of a tract. If one or two thousand acres of mixed hardwood forests were worked over annually, about twelve to fifteen varieties of timber would be produced or about the same number or even less than are produced on a similar area in the United States. The various species when converted would be kept separate, except in cases of species so alike in quality as to be suited for the same purpose. Such species might well be marketed under one name. Several hundred or several thousand tons of each species would be

accumulated in stock. There would be the assurance of like quantities through succeeding years, and the difficulty of mixed species, no worse on any one large tract in Burma than in the United States, where thirty species are sometimes found together, would be solved.

There are several important reasons why the opening up of the mixed forests of Burma by railroad should be considered :—

1. The hardwood forests of America are becoming exhausted.
2. Other countries, no more favoured than Burma, are now entering the export field.
3. A large market exists in Europe, India and Africa.
4. The revenue of the province would be greatly increased.
5. The means would be provided of more profitably introducing the Uniform system.
6. The development of local industries would be encouraged.
7. Mechanical skidding machinery would be rendered possible.
8. Resultant concentration of operations would facilitate control by Forest Officers.

The industrial countries of the world are yearly importing increasingly larger quantities of hardwoods. The home demands of the United States and Canada and the steady export drain have already put several important species practically beyond reach and have reduced others to the point where export supplies are available for only a few years longer. Already a trickle of trade, destined to increase, has set in the other way, and tropical hardwoods, for house-finishing, electrical industries, railway coach-building, cabinet work and furniture-making are being imported into both the United States and Canada. It will soon become necessary to find a new source of supply. As American supplies become scarce, prices will increase, giving Burmese woods an even more favourable opportunity to compete. As American hardwoods become exhausted, the trade names under which they have been sold, hickory, ash, oak, chestnut, elm, walnut, cherry, will gradually lose a leading position on the market and the competition of woods with hitherto unfamiliar names will be facilitated.

Whether the future export trade in hardwoods is carried on from Burma, Japan, the Philippines, Borneo or Siam, will depend very much on the initiative shown in developing Burma forests.

As compared with the countries named, Burma not only possesses the largest forest areas to be found in the countries named but also possesses the areas most advantageously situated with regard to the export market. Shipments made to India alone in recent years from the above countries show that the development of mixed hardwood forests is already an important factor in the trade of countries possessing no natural advantages over Burma.

Imports of manufactured and unmanufactured hardwoods into India in 1913-14 from countries recently undertaking production of hardwoods :—

Countries of origin.			Value. £
Japan ..	..	...	... 277,764
Straits ...	..	..	... 99,767
Java ..	...	...	... 10,629
Philippines	...	.	... 3,030
		Total	... 391,190

No statement of imports is necessary to show the great demand in Europe and elsewhere for hardwood timber suitable for manufacturing and industrial purposes. The industrial nations of Europe have long since ceased to meet their own requirements and have become yearly increasingly dependent on America, a source which already shows signs of failing.

The home market in India is very important. The annual imports of hardwoods, which might well be supplied from the accessible Burma forests, are :—

			Value imported in 1913-14. £
Tea chests	...	...	.. 349,435
Sleepers ...	...	...	.. 255,153
Manufactured articles		...	... 64,282
		Total	... 668,870

The tea chests are nearly all made from hardwoods, chiefly alder and birch. A large proportion of the sleepers and almost all the manufactured articles are similarly made from hardwoods. Furthermore the commodities listed above do not require such qualities of timber as would be difficult to secure in the forests of Burma.

It is simply a question of getting the timber out in somewhat the same manner as it is taken out in other countries. Forests more difficult to reach from the sea than some of the forests in Burma, and no richer, are being developed ten to twenty thousand miles away and the manufactured timber exported to India in large quantities.

The sleeper trade of India alone offers great possibilities. One of the obstacles now in the way of its development is the fact that local timbers are not cut on a sufficiently large scale, either to provide commercial sized shipments of the durable timbers, or to make it worth while to give preservative treatment, as is done in other countries, to the sufficiently hard, but non-durable, timbers.

South Africa is under the necessity of importing all her timber requirements. The large quantities of hardwoods now imported come chiefly from America and Australia. Neither of these supplies will continue indefinitely; Burma is well situated to take up the trade.

No volume of export trade in hardwoods appears to be too large for Burma to contemplate. The mixed hardwood forests of Burma cover as large or larger areas than the original total hardwood forest areas of the United States, they are more accessible, and they have the added advantage of coming into development at a period when the demands for hardwood are greater and more varied, the prices higher and the facilities for extraction and manufacture much more highly developed than was the case when North American forests were developed.

Lacking a valuation survey, it has been estimated that the mixed hardwood forests of Tharrawaddy would produce fifteen tons per acre exclusive of teak and that the royalty would average

seven rupees per ton. A revenue from royalty of at least one hundred rupees per acre exclusive of teak on forests now unused would appear likely to be a very important factor in provincia revenues. This revenue might be increased by the increased royalty procurable from bamboos if a cheaper means of extraction were provided by railroad The development of the hardwood forests would probably proceed slowly, but, taking into consideration the world demand for the timber, the exhaustion of other areas, and the accessibility of the Burma forests, there appears no sound reason why the revenue from mixed hardwoods in Burma should not eventually rival that from teak

The extraction of hardwoods by railway neither implies nor necessitates forest destruction. Under the conditions prevailing in the Tharrawaddy Division it appears that the introduction of the Uniform System might be accomplished at a profit, by the cutting and sale of mixed species if rendered accessible by railroad, whereas at present it is being accomplished at a great loss of valuable timber which is felled and which, owing to lack of means of extraction, must be left to rot on the ground.

Should it be desired to work the forest on the Uniform System for the regeneration of teak, cutting and extracting operations could be carried on over a compartment for two or three years in succession, or, if necessary, the felling might extend over a longer period. In that case it would be necessary to group three or four compartments to be worked over simultaneously.

Another sylvicultural advantage would be that such areas as are not adapted for teak could be managed for the production of other species which, though valuable and useful, cannot now be considered because they will not float. It would become possible to consider the whole forest area valuable and revenue-producing to extend sylviculture to cover all areas and all valuable species, and Burma would no longer be a one-tree Province nor Burma forestry a one-tree profession.

Extraction on a large scale by bringing to a common point a constant supply of logs of the various species suitable for the manufacture of matches, bobbins, tea chests, creosoted sleepers,

must precede the development of such manufacturing industries. The proprietor of a match factory can neither pay any one else nor undertake himself to cut over a forest in which scattered trees only are fit for his purpose; the same holds true for the capitalist who would engage in the other industries, yet there are undoubtedly trees in the forests of Burma eminently suitable for raw materials for these industries. When the facilities are provided for the extraction of all species at one time, subject to sylvicultural safeguards, timber will be made available at central points at such costs and in such constant quantities as to justify the erection of factories and the launching of those important industries which in other countries work up forest products.

If elephant and buffalo power continue to be available in sufficient quantities at the prices now paid, it should be possible to undertake the profitable extraction of mixed hardwood forests by railroad without the introduction of mechanical skidders. Nevertheless, mechanical skidders may, through the growing scarcity of animals, become necessary in the ordinary course of extraction in Burma. Under present conditions, where the felling schemes are on a small scale, only small areas are cut over at one time in one place. Where only one or two species are taken, the prospects of skidding machinery, even should it become necessary through lack of animals, are not favourable. On the other hand, should extraction by railroads be undertaken and if a cheap means of moving the skidder by railroad be provided, the cost of removing the timber could probably be reduced by the use of skidders with a resultant increase in royalty to the Government.

Undoubtedly one great difficulty confronting Forest Officers in Burma is the necessity for giving personal supervision with a small staff to many small scattered felling areas. Much valuable time is unavoidably lost on the road and a forester, as is perhaps the case everywhere, comes to the conclusion that he earns his living with his feet rather than his head. The concentration of felling schemes under areas worked by railroad would make possible a more intense supervision

The possibilities outlined in this paper have been based on an impression gained by walking through fifty or sixty miles of forest and making ocular estimates of timber on average quarter acre plots. It appears well worth while to make a valuation survey of forty or fifty square miles of forest on an accessible area in such a division as Tharrawaddy, and if the amount of timber discovered justifies it to make an estimate of the cost of building and operating a railroad for the hauling of the timber, the estimate of the timber and the preparation of a stock map do not require the presence of a person experienced in railroad logging. The estimate of the cost of building and working the railroad with its branches, the detailed estimate of the cost and plans for the method of extraction and conversion should be made in conjunction with the District Forest Officer by some one conversant with railroad extraction.

The benefit to be gained by making accessible and profitable the great areas of hardwoods in Burma are so great financially, industrially and sylviculturally, that it seems well worth while to spend on a valuation survey of timber available, and an estimate of the cost of extraction, the small sum necessary to determine the exact possibilities.

The great value of the teak forests should not be allowed to obscure the possibilities of the other species.

The suggestion has been made at different times that foresters from certain North American districts would find more to learn from a study of the work carried out on a large scale in India than from the more intensive operations in Europe. The writer is inclined to agree with this suggestion. No forester can come in contact with the professionally keen Indian District Forest Officer carrying on his work alone under personal discomforts unknown either in Canada or the United States without receiving inspiration. No forester can become acquainted with the sweeping accomplishments of the Indian Forest Service which, within fifty years, replaced forest destruction by the introduction of forest management over an area unequalled elsewhere in the world for difficulties, without acquiring a greater respect for his profession. One of the finest

features of British administration in India must be that represented by the work of the two generations of Forest Officers, a handful of Europeans amongst three hundred million natives, whose every habit is opposed to the aim of forestry. That these few foresters in half a century should have brought forestry in India to the present stage, where practically destroyed forests are being regenerated and formerly inaccessible forests are being worked in such a manner as to demonstrate almost as well in Europe, the working of the various systems of sylviculture, must appear to any visitor absolutely incredible. Foresters from India might also benefit by visiting North America. The home of forest destruction is likely to show the most economical methods of extraction and of manufacture. Foresters from Burma especially, where large areas of untouched forest yet exist, might, by visiting the steam logging operations of America, and the large well-organised saw-mills, judge more accurately than has been set out above, the greater possibilities of Burma forests.

FOREST GROWTH ON OLD SHIFTING HILL CULTIVATION.

BY A. RODGER, I.F.S.

The problem of how to replace the forests destroyed by *taungya* cutters is always of interest, and the accompanying photograph (Plate 46) shows a first-rate example of what nature can do unaided in its solution. This wood was seen in the Prome district in unclassed forest at an elevation of about 500 feet on the outer skirts of the Pegu Yomas, on the *Thithlagyaw* to the north of the village of Ngashinkwin. The slope was moderate, the soil fairly good loam, and bamboo (*Dendrocalamus strictus*) was scarce in the neighbourhood. The area had been cut over about 17 years before and the photograph was taken in December 1915, by which date the ground had been largely occupied by good dense pole growth. Three countings were made and the following figures obtained:—

Number of stems per acre	1,150
Timber down to 2 ft. girth : cubic feet per acre	165
Small wood : cubic feet per acre... ...	1,108
Total ...	1,273

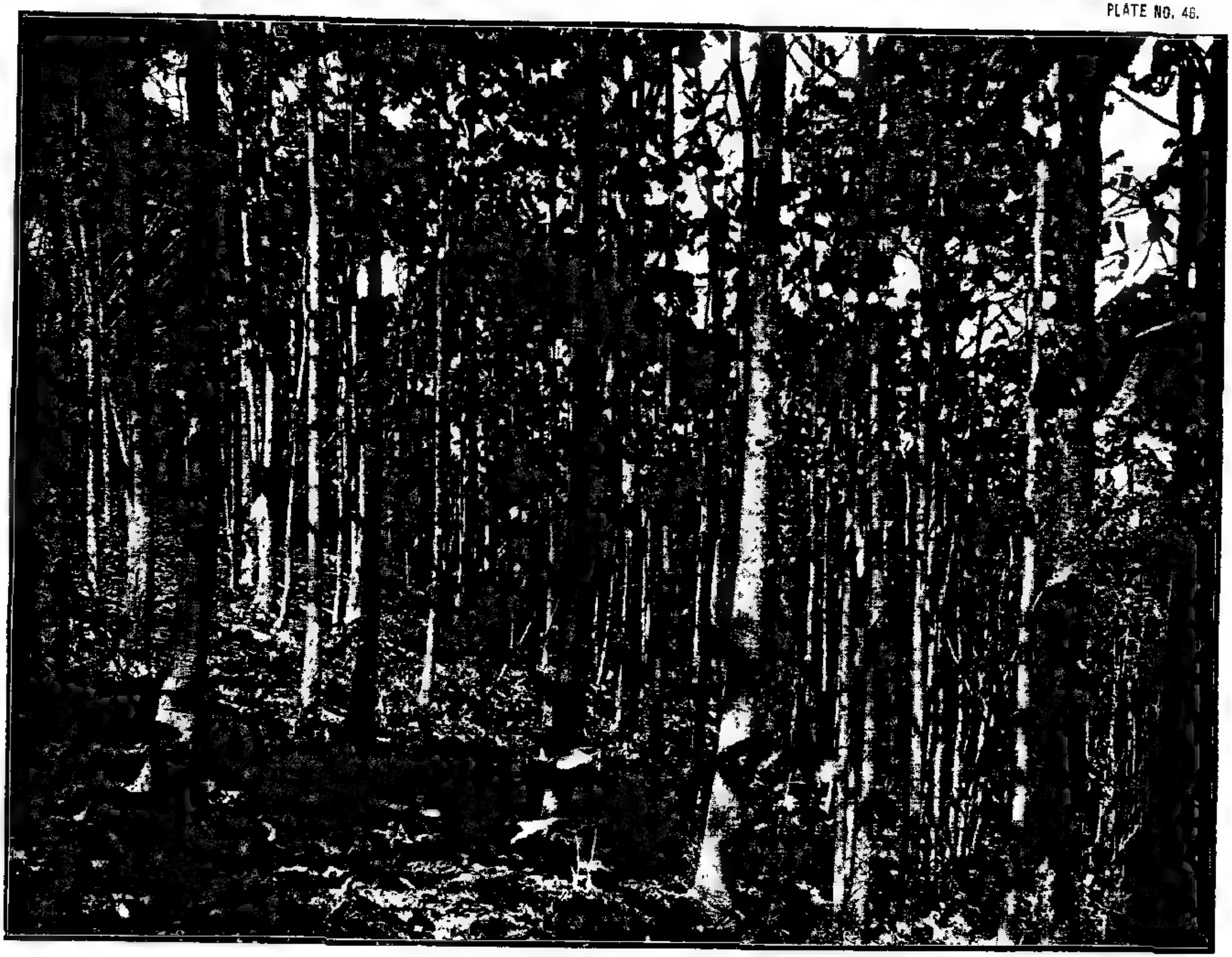


Photo-Mechl Dept., Thomas'n College Roorkee.

FOREST GROWTH ON OLD SHIFTING HILL CULTIVATION.

The volumes were calculated from sample trees of all sizes which were felled. Seventy four per cent. of the trees were below one foot in girth and the largest measured $3\frac{1}{2}$ feet in girth at breast-height. *Stephegyne diversifolia* (Binga) formed 72 per cent. of the total crop and almost all the stems of this species measured less than 14 inches in girth. The species coming next in numbers were *Hymenodictyon excelsum* (Kuthan), *Bombax insigne* (Didu) and *Berrya Ammonilla* (Petwun), but there were only 25 of the last-named per acre. There was also a sprinkling of *Erythrina* sp., *Odina Wodier, Spondias mangifera, Lagerstrœmia villosa* and a few others. The number of stems and volume per acre compare quite well with the same figures for a carefully tended teak plantation in the neighbourhood, 13 years old, in which there were 690 stems and 1,385 cubic feet of small wood per acre.

NOTE ON THE COLLECTION OF SAVANNAH GRASSES FOR PULPING EXPERIMENTS.

BY W. RAITT, F.C.S., CONSULTING CELLULOSE EXPERT, FOREST RESEARCH INSTITUTE.

In the published report on Savannah Grasses (Indian Forest Records, Vol. V, Part III), attention is drawn to the constitutional differences between various parts of the species dealt with in order to emphasize the greater value of flower culms. Thus the flower culm of *Saccharum Munja* was found to yield 42 per cent. of fibrous cellulose against 34 per cent. for leaf culms. The average for the whole plant came out at 40 per cent. showing that the greater proportionate weight of the former so far wiped out the lesser value of the latter as to make the distinction of little practical value. The samples dealt with were small in quantity and contained little or no *immature* leaf and probably the weather conditions prior to their harvesting were unfavourable to its production. Recent experience with grass collected on a considerable scale makes it desirable to issue a warning against *immature leaf.*

The character of the cellulose skeleton of a grass depends largely on the work the plant has to do and the forces it has to

resist and the excellent quality of the cellulose found in the flower culms of Savannah Grasses is due to the culm having to force its way to a considerable height above its leaf mass and there to carry an apparently top-heavy flowering head swinging freely in wind-swept spaces and resisting the beating down effects of wind and rain. The stem must, in a large degree, develop flexible rigidity, and it is just this quality of *flexible rigidity* which we readily recognize in the individual fibres of its cellulose skeleton. Wood cellulose does not possess it, for in the tree resistance to the elements is provided by highly liquified solid tissue.

The leaf culms have no such serious strains to resist; they do not rise to so great a height, they are massed in the clump to an extent which gives them mutual support and their cellulose structure is organized accordingly. It is inferior to that of the flower culms both in quantity and quality, but when it represents a growth of several months and therefore has had time to develop and mature, such inferiority is not enough to make a serious difference to either the yield, or its quality, of the whole crop. The case is very different with immature leaf, by which I mean short leaf of probably only a few weeks' growth crowding up the bottom of the clump and from twelve to thirty inches in length. In a normal season probably little of it will appear and the conditions that induce it may be a prolonged dry break of the rains in August—September followed by their recurrence for a short period prior to their final cessation, or, the interjection of a few wet days during the normally dry weather of the cropping season. The effect is a dense quick rush of short leaf which has its development immediately arrested by the recurrence of dry weather. When thoroughly sun-dried, it may be ground to powder by merely rubbing it between the hands and a material which behaves thus has no value as a cellulose producer.

Its effect upon the cellulose result of the whole crop would not be serious if it meant only a reduction of the average yield, but it goes further than that. Such cellulose, as it contains, has an abnormal proportion unorganized, *i.e.*, in true cellulose form, and that which is in fibrous form has only begun the organizing process

and is in tender non-resistant fibres of about 0·5 mm. length instead of the tough 2·5 to 4·0 mm. fibres found in the flower culms. Both forms break down during the digestion process into a viscous débris which agglutinates itself on to the good pulp and seriously interferes with the proper after-treatment of the latter. No pulp is of much use to the paper-maker unless it is what he describes as "free," a condition in which the individual fibres are capable of floating independently on each other and the precise opposite of agglutinated and matted masses. It also interferes considerably with the bleaching of the pulp being itself almost unbleachable.

Fortunately it is a simple matter to prevent the admixture of immature leaf. Whenever such growth is present I would recommend that it be left on the ground by grasping the whole cut mass of the clump at about four feet from the cut end and shaking the short stuff out.

DEMARCATION OF FOREST RESERVES IN BURMA.

BY A. J. BUTTERWICK, P.F.S.

1. According to the rules now in vogue, the following is the method usually adopted for demarcating forest reserves in Burma. The outer boundary is delineated by means of pillars or posts, boards, and blazed trees, whereas the inter-compartment boundary is marked by pillars or posts at the junction of two or more compartments, and blazed trees. This article is not concerned with boundary pillars or posts, but only with the system of blazing trees, which, in the writer's humble opinion, is neither desirable nor required. As a matter of fact, as may be seen from the accompanying photos (Plates 47—49), it is in some cases very injurious to the trees themselves.

2. The following are the rules which govern the blazing of trees for demarcation :—

"Trees under one foot in diameter should not be blazed if a sufficient number of larger trees are available. The blazes will be cut at a convenient height from the ground on the outer side of

Fig. 1.

Fig. 2.

Fig. 3.

Fig. 4.

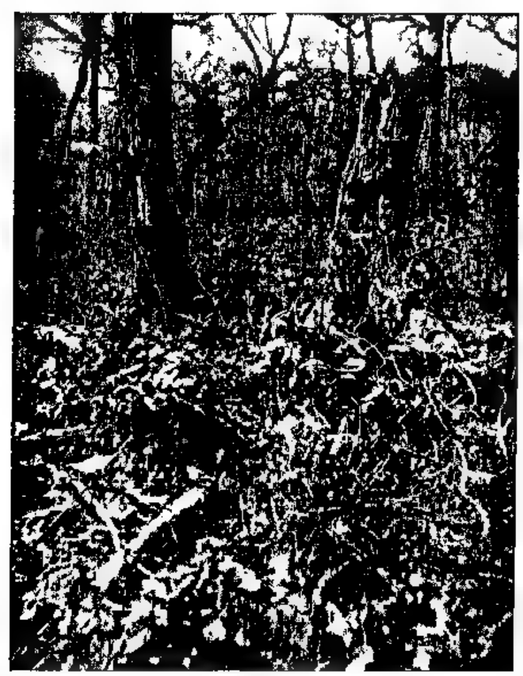


Photo-Mechl. Dept. Thomason College, Roorkee.

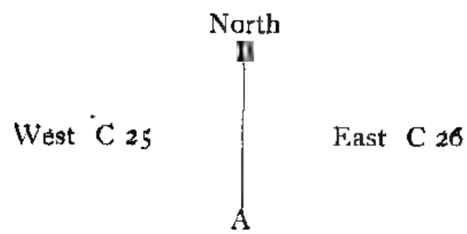
DEMARCATION OF FOREST RESERVES IN BURMA.

trees, on or within the forest as near as possible to the boundary line, and will face outwards. They should have a well and clearly cut face, both edges of which will be bevelled well back to delay occlusion, sufficient of the heartwood being exposed (in the case of trees having a distinct heart) to take at least three clean impressions of the demarcation hammer.

"Inter-compartment boundaries shall be blazed similarly to reserve boundaries, but the trees shall be blazed on both sides, each blaze being marked with the compartment hammer."

Again later orders on this subject are :—

"Blazes must face away from the compartment to which they refer; thus in the diagram below, when walking north along the ridge AB, blazes marked 25 will be seen facing east and blazes marked 26 will face west.



"Several impressions of the number may be put in the centre of the blaze, and the C hammer put round it. To indicate places where posts have been put, it is advisable to have, say, three trees close to the post, on each line meeting at the post, blazed twice, one blaze above the other.

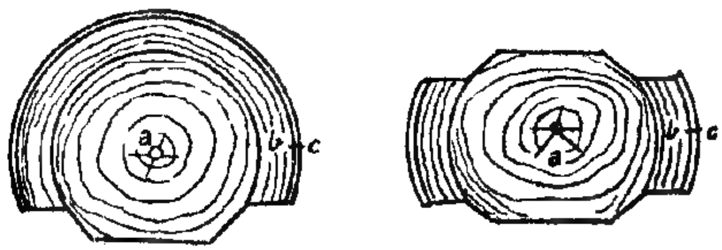
"Teak trees must never be blazed unless they are useless for timber or there are no other trees to blaze. Numbers should be struck on the heartwood. It is better to have a few large trees blazed than a large number of small trees; as the latter often break and rot. From one blazed tree the next should be easily visible."

3. From the above rules it may be concluded that the following trees should not, ordinarily, be blazed :—

(*a*) Teak trees. (*b*) Trees under one foot diameter. (*c*) Trees without a distinct heartwood. (*d*) Trees some distance from the boundary line.

The officer doing the demarcation is, therefore, limited in his selection of trees to be blazed. Also it may be noted that in the outer boundary lines, trees will be blazed in one place, on one side only, except near pillars or posts, where a few trees are to be blazed in two places, one blaze being above the other. Along inter-compartment lines trees will be blazed on both sides, and it is surmised that near pillars or posts a few trees will be blazed twice on both sides. On the blazes along the outer boundary of the reserve the R hammer is marked, whilst on those along the inter-compartment boundaries, the C hammer, together with the number of the compartment, is struck.

The following sketches show the transverse sections of trees blazed on one and on both sides. The blazes have been splayed out according to the rules, to prevent rapid occlusion :—



a=heartwood. *b*=sapwood. *c*=bark.

4. The practice of blazing trees has two advantages, in that it not only demarcates the reserve, or compartment, but also serves to help one to find his place easily on the map. Besides it is a comparatively cheap way of demarcation.

It has, however, the following great disadvantages :—

(*a*) The blazes are not permanent, as in anything from ten to fifteen years, they are completely occluded and the hammer marks are either obliterated or hidden from view.

(*b*) Blazes injure the trees badly, as they not only vitiate their vigorous growth, and form misshapen boles, but also serve as entrances for harmful insects and fungi. Also in many cases trees deeply cut in are blown down by the wind. Further in Plate 48, Fig. 7.

Fig. 5

Fig. 6,

Fig. 7.

it will be seen that the heartwood exposed by the blaze has been badly scorched by fire.

(*c*) Repairs to a blazed tree are expensive as they have to be carried out comparatively often, if the demarcation is to be of any use.

(*d*) As the hammer marks on the blaze are all in English characters, the Burmese "tawtha" coolies are, in the majority of cases, not able to read them or to know the number of the compartment.

(*e*) As the outer boundary of the reserve is marked with the R hammer only, it is not possible for any one not thoroughly acquainted with the reserve to tell which compartment lies on the other side of the blazed trees.

5. To show the damage done to trees by blazing, the writer ventures to attach some photos (Plates 47—49) of blazed trees and the following remarks are here given to explain them :—

Plate 47, Fig. 1. The tree in the foreground has been blazed twice, the lower blaze being the more recent, about 12 years old. The tree on the left has been more recently blazed, about 6 years ago.

Fig. 2. This tree was blazed about 12 years ago. Occlusion has partly taken place and a cavity has been formed.

Fig. 3. A "Shah" (*Acacia Catechu*) tree blazed twice. The lower blaze is the more recent, about 10 years old. It has almost completely occluded.

Fig. 4. The stump on the right belongs to a tree, which was blazed too deeply and which was blown over. The other blazes were done about 9 years ago.

Plate 48, Fig. 5. This tree shows an occluded blaze made about 11 years ago.

Fig. 6. This tree stands near a boundary pillar and shows the two blazes (about 4 years old) required under the rules.

Fig. 7. A very large blaze, partly occluded, and a misshapen bole are shown here. The blaze is about 5 years

old. The heartwood has been badly scorched by fire.

Plate 49, Fig. 8. This shows the injury done to a tree by a blaze 4 years old.

Figs 9 & 10. Both these photos show the same tree with two blazes, the lower of which is the more recent, about 4 years old. The bevelling back of the two sides required under the rules is clearly shown here. The hammer marks on it are not distinct.

The above photos are of trees which have been blazed on one side only. The writer has not yet seen trees blazed on two sides according to the rules. It will be readily agreed that the serious injuries done by this one-side blazing will be enormously increased by the two-sided cutting.

6. When a blazed tree is repaired, either the old blaze must be opened out and deepened, or else a new blaze be made either above or below the old one. This may be seen in several of the accompanying photos. After the tree has thus been repaired two or three times, its vitality is bound to have become so impaired that it will either be killed and rot away or else be blown down by a strong gust of wind. It may be contended that in the forests of Burma there are so many trees along the boundaries that if one falls there is always another to take its place. But as stated above in paragraph 3, the demarcating officer is limited in his selection of trees for blazing. Further, there is an increasing demand for good timbers besides teak, and, as in the case of teak, this demand will not allow any tree of the more valuable species being blazed for demarcation purposes. It is just these valuable species then, which, having a durable heartwood, are able to bear the heavy blazing for some time. Other inferior species soon get fungus or insect ridden, and in a short time become hollow and rotten.

7. In the writer's opinion, instead of blazing the trees as is done now, demarcation should be done in the following manner :—

(*a*) Along the outer boundaries "Asoya (အစိုးရ)" boards, as used at present, should be placed every 20—50

Fig. 8.

Fig. 9.

Fig. 10.

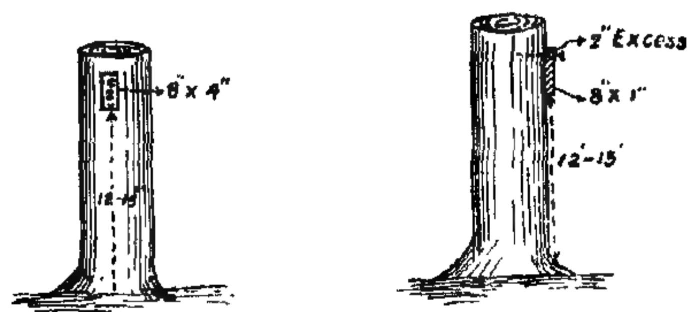
Photo-Mechl. Dept., Thomason College, Roorkee.

DEMARCATION OF FOREST RESERVES IN BURMA.

yards apart, the distance depending on the locality of, and density of growth in, the forests. These boards will be nailed about 12—15 feet high on trees, to be out of the reach of elephants. They should be made as at present, except that the letters should be stamped on them by means of marking hammers. The letters will then be filled in with black paint.

(*b*) Along both the outer and inter-compartment boundaries small boards should be placed high up on trees about 10—50 yards apart. Each board will be 8″ × 4′ × 1.′ It will be painted white and have stamped on it, by means of iron dies, the letter C, and the number of the compartment in English and in Burmese numerals. These will be painted in with black paint.

Below a sketch is given to show what is meant :—



From enquiries made it is estimated that the cost of each such board, including its fixing up on the tree, will not exceed annas four.

The advantages of having these boards, instead of the blazing, are manifold :—

(*a*) The trees are not injured in any appreciable manner.

(*b*) Small trees of inferior species can be used and the more valuable trees left alone.

(*c*) Adjacent compartments can easily be marked on the same tree.

(*d*) The numbers and letters having been sunk into the boards, they will be practically permanent, and will last as long as the timber does.

(*e*) The boards, having been placed high up on the trees, will be more easily seen than the blazes, which are lower down.

(*f*) Burmese coolies will be able to read the numbers of the compartments.

(*g*) The outer boundaries will have the respective compartment numbers marked along them.

(*h*) The demarcation lines will not require repairs as often as they do now.

The disadvantages of the system now advocated, appear to be—

(*a*) the cost of demarcation will be much higher ;

(*b*) the boards are apt to be broken, burnt, or stolen.

Regarding the first, this is fairly well counterbalanced by the diminished cost in repairs and by the fact that the trees are not injured in any appreciable way. Besides, in the writer's opinion, the demarcation will be much more distinct and therefore more valuable and efficient. Regarding the second, the writer has taken notes of the "Asoya" boards, used at present, for the outer boundary, and he has found that a very small percentage of them is lost in this way. It may also be contended that, as regards the outer boundary, the boards may easily be taken off and nailed on to trees much further in, thus encroaching on the forest reserves. This, however, is not likely to happen, as with the boundary notifications, maps and records in use in every Divisional Forest Office, there is always a sufficient check in hand. In the many forests in Northern India, visited by the writer, blazing of trees was never done to demarcate the reserves, and in those parts of the country the population was far denser and the land comparatively more valuable than in the majority of places in Burma.

NOTE ON GOLPATTA.

BY LIJAY KUMAR BHATTACHARJI, FOREST RANGER.

Golpatta (*Nipa fruticans*) is not only the most important article of minor produce of the Sundarbans Forests, but is one of the most important and most valuable of the minor products of Indian Forests. Out of the 6 lacs of annual revenue from the Sundarbans, more than a lac of rupees is derived by selling the Gol-leaves.

Locality.—It is found growing luxuriantly on the margins of all rivers and khals in the Sundarbans as far as saltness pervades their water. In fact, the presence of sufficient quantities of salt seems to be a *sine quâ non* for its existence.

It forms a sort of fringe to the Sundarbans Forests, but seldom penetrates deep into them. It thrives best in the tract of land lying between the low and high water-levels, at ebb and flow tides respectively. Occasionally it is found extending a little above the tide-mark, and entering into the forest. As the saltness in water diminishes, its place is taken by its fresh-water kindreds -cocoanut (*Cocos nucifera*), betel-nut (*Areca Catechu*), date-palm (*Phœnix sylvestris*), and palmyra (*Borassus flabellifer*) which form beautiful groves along the banks of all big rivers of the Khulna and Backergunge districts. Indeed, it is a pleasant journey through these rivers along the avenues of these palms just before sunset when the crowns of all these tall palms are still illuminated by the rays of the setting sun, giving them, as it were, the appearance of a row of chivalrous princes, setting forth in battle array with their glittering golden crowns.

Soil and Climate.—It grows best in alluvial deposits of clayey loam with an admixture of sufficient quantities of common salt. It is only suited to tidal regions. During flow tides, the whole plant, with the exception of a few tips of leaves, is buried in water. This peculiar habit whereby a part of the stem remains submerged in water for a few hours every day, makes Golpatta independent of rainfall. A considerable amount of heat as well as the direct rays of the sun, are necessary for the germination of the seed and the development of the seedling.

Shape and Development.—Golpatta has no over-ground stem though it develops a considerable so-called rhizome under-ground. This under-ground stem, which is thick and fleshy and densely packed with reserve food materials, broadens near the surface of the ground, whence the leaves develop. As in other palms, the new leaves are plicately folded into long cylindrical spears. As they grow older, the folds untie, the leaflets spread out and the leaves attain their normal full-fledged form.

The leaves are fibrous and the rachis strong and heavy. If left to itself and uncut for some years, the rachis becomes extremely heavy and unwieldy, so that purchasers do not like to cut it. Frequent cuttings give tender rachises and finer leaflets—much sought after by purchasers. The leaves, in favourable localities, attain a height of 12 to 18 feet.

Golpatta is a light-demander and is fairly fast growing. It takes about 18 months to 2 years from the germination of the seed to the time when the leaves are fit for cutting.

The green wood has about the same specific gravity as fresh water and will not float in it, though it does float in salt water.

Reproductive Power.—It bears fruit annually. The inflorescence is an oval-shaped terminal spadix covered by a thick, fibrous spathe. The infructescence is also covered by a sheath when young. The fruit is a ribbed, obovate drupe. The seed is enclosed within a fibrous rind—the kernel being covered by a hard osseous shell.

The flowers are formed in March and April, and the fruit ripens by the next February or March, when it is fit for collection. The percentage of fertile seeds, however, is small. Germination is very rapid and is independent of all extraneous circumstances. The young shoot is sometimes seen peeping forth as soon as the fruit falls. Reproduction under the parent tree is seldom effected by seeds. The rhizome, however, is very active in sending forth new flushes of leaves as soon as the old ones are removed.

Character and composition of the Forest.—It grows in pure compact masses along the banks of channels—sometimes alternating with patches of mixed forests composed of Hantal (*Phœnix*

paludosa), Hargoza (*Acanthus ilicifolius*), Bhola (*Hibiscus tiliaceus*), and in some places Udoban (*Acrostichum aureum*), Sundrilota (*Derris sinuata*), Kewa (*Pandanus fascicularis*), and Nal (*Phragmites Karka*). Of these Hantal affects the same sort of locality as Golpatta and also forms pure crops. The compact groves of Golpatta are favourite resorts of tigers during the hot noon-day sun.

Method of Treatment.—It is at present treated as minor produce and sold by permits. But though its present abundance does not warrant any regular method of working, still as the demand for it is gradually increasing, a time will soon arrive when some regular method of treatment will have to be prescribed for the working of this valuable species. As the rachis becomes tender and the leaflets finer by frequent cutting, the method of simple coppice or clear felling may be suitable for it.

As the forest is by itself clean and pure, no subsidiary operation is necessary.

Method of Extraction and Stacking.—Golpatta, like everything else in the Sundarbans, is transported by boats. These boats have to pay royalty according to their capacity in maundage by boat measurement.

Formerly, after cutting, the Gol-leaves were spread on the banks for drying, so that they might be lighter and occupy less space. This custom is now disallowed, as it means a loss to the Government, as much more leaf could be loaded in a boat by that process. Clever purchasers, however, throw away the rachis, which is useless, as well as the heaviest part of the leaf. The leaves are then spread to their full size and stacked one above another either on a wooden platform, made for the purpose, or from the bottom of the boat, to the maximum height, commensurate with the safety of the boat during storms. Tiers of Gengwa (*Excœcaria Agallocha*) logs are introduced at intervals to press down the leaves. Gengwa jhools are also put at water-level along the sides of the boats, in order to steady them, as well as to counteract the force of the wind striking against the high stack of leaves. As in the case of all other vessels, these boats can ply up or down with the tide and never against it.

Economic Uses.—The peduncle of the newly-formed flower is eaten raw or cooked The kernel of the fruit, before the stone hardens, is sweet and is greedily sought after by children. The ripe kernel is being experimented with for button-making, and if the experiments are successful, there will probably be a large demand for it. However, the most important part of the plant is the leaf. It is extensively used as a roofing material. Most of the houses of the poor in Calcutta and the suburbs are roofed with it. It is also largely used for rough walling, umbrella-lining, basket-making, mat-making and the like purposes. The rind also yields a fibre, which, but for its shortness, might be a useful substitute for coir-fibre. A fibre may also be extracted from the leaves and leaf sheaths.

BEE-HOLE BORERS AND A TUCKTOO.

BY A. R. VILLAR, I.F.S.

During the month of April I was placed on special research work on the Bee-Hole Borer in the Bhamo District. For the benefit of the uninitiated it may, perhaps, be necessary to explain that the so-called Bee-Hole Borer has got nothing to do with bees but is a large moth (*Duomitus ceramicus*), the caterpillar of which tunnels a gallery in the heartwood of teak some 8—10 inches long.

After some preliminary investigations I finally settled down at Okchi, on the lower Kaukkwe river, where I had found a small area of pure natural teak forest to be very badly infested with the pest.

The first emergence of the moth took place on the 21st April, on which day a pupal skin, just clear of the thorax, was found sticking out of a teak tree. On the 23rd April between 1 and 3 o'clock in the afternoon a large female moth emerged from a piece of teak wood which I had tied up in the Rest-house and enclosed in a mosquito netting cage. This moth was transferred to an ordinary camp cot mosquito-net which was fixed up in the corner of the western bed-room. An ordinary Burmese grass-mat or *Thinbyu* was placed on the floor beneath the net to stop

anything getting through the cracks of the floor and the ends of the net were held firmly down to the floor by means of the weight of bamboos.

On the evening of the 26th April, shortly after 8 o'clock a large moth flew in at the verandah of the Rest-house and after flying round two or three times settled on the mosquito-net exactly opposite the place where the large female moth had taken up its position on the inside of the net. It was easily captured and closer examination proved it to be a male *Duomitus ceramicus*. Previous to this the female had been very quiet. Now, however, both moths were rapidly vibrating their wings, producing a low humming sound, more audible in the case of the female owing to the larger size of the wings. Soon after this I noticed that the female had laid an irregular row of eggs on the top of the net. I cannot state positively whether the eggs were laid before the arrival of the male. If so it could only have been a short time before. In any case no pairing took place, for the eggs were sterile. The female which is provided with an ovipositor about an inch long continued laying eggs about the net in rows and masses, frequently pushing the ovipositor through the holes of the netting but taking no notice of a freshly cut piece of teak which I put in the net.

On the morning of the 22nd, just before 11 o'clock another moth (of my captive specimens) emerged from a specimen of teak wood kept in the bungalow and proved to be a male. Its wings, however, never developed properly as the pupa had apparently been damaged. This moth was also transferred to the mosquito net and during the day-time all the imagos remained motionless becoming active again in the evening, vibrating their wings and the female continuing to lay sterile eggs.

On the night of the 27th, about 11 o'clock I caught another male moth under almost identical conditions as on the 26th. As instances of sexual attraction, these two cases are probably unique.

To capitulate, therefore, I had now in the mosquito-net three male moths and one female, on the night of the 27th. Two of these moths, the female and the damaged male, emerged in captivity during the day-time (apparently normal), the other two males

being captured at night outside the mosquito-net to which they had been attracted by the female On both nights the female, in the presence of the males, laid quantities of sterile eggs. The moths appear to be active at nights only

Early on the morning of the 28th I went to see how my captures were progressing, when to my dismay, I found only the remains of wings They could, therefore, not have flown away nor indeed was it possible for them to get out of the net. Further examination revealed a tear about two inches long at one end of the net near the botton just above the cotton border. My first thoughts suggested rats, but this theory was clearly untenable. My next idea was the Taukte (anglicised tauktoo), which lived behind one of the posts in the other bed-rooms of the Rest-house. On asking some Burmans they immediately suggested a taukte as the miscreant. An immediate onslaught was, therefore, made on the taukte behind the post. By means of hot water poured down from the top of the post accompanied by the prodding of several Das (Burmese long-bladed knives) he was eventually dislodged from behind one of the scantlings, securing the end of the split bamboo wall behind the post and quickly killed, being somewhat mutilated, I am sorry to say, in the process Examination of the contents of the stomach confirmed my suspicions, for it was undoubtedly full of the remains of my moths. He had made this hole, scotched all my moths and then got out again through the same hole. He must also have eaten some of the eggs, because the first row about 2 inches long laid by the female had also disappeared This moth was in the habit of resting near or over this row of eggs (no doubt to protect them), and the probability is that she was near them when attacked by the tucktoo. One of the things which have still to be ascertained is the cause of the high rate of mortality of *Duomitus ceramicus*, for each female moth lays between four and six hundred eggs. I think, after this experience, we can rightly class the tucktoo (*Gecko* sp.) as one of the enemies of this pest and a true friend of the forester in Burma.

EXTRACTS.

SOME USES OF PRICKLY-PEAR.

The Director of Agriculture, Madras, has issued, in the form of a departmental leaflet, the following Note on some uses of prickly-pear:—

The prickly-pear plant is considered by many ryots as a curse to the country, as it has overrun immense areas in several villages. In some places, much agricultural land has been rendered temporarily useless from having been taken possession of by this troublesome pest. In very many villages, the scrub jungles are overgrown with it and the land which would have otherwise been useful for growth of trees and grasses is occupied by it. It forms a safe refuge for snakes, etc. By the spread of this plant several public thoroughfares are becoming narrower every year, whilst poramboke (waste) lands are not infrequently rendered useless thereby for any purpose. The ground close to these bushes is used as a public latrine by villagers which encourages the growth of the plant and does not add to the amenities of the village. The eradication of prickly-pear in villages is therefore one of the serious problems with which ryots have to contend.

Although attempts are being made here and there by public bodies such as taluk and district boards to eradicate this plant in

very congested areas, yet such work is only practicable on a large scale if ryots in all the villages assist in removing it.

In parts of Coimbatore district, prickly-pear is used after decomposition and composting as a manure for dry land crops such as cumbu, cholam, dry ragi and garden crops like ragi, chillies, tobacco, wheat, plantains, sugarcane, etc. This is, however, not resorted to by all In many cases it is prickly-pear growing in corners of their fields or extending from outside into the fields that is cleared and composted by way of disposal. A few ryots compost prickly-pear especially when it is abundantly available near at hand ; but this is not followed as much as it might be.

Ryots, however, have taken up to the practice of carting to their fields the earth which accumulates under prickly-pear bushes for improving their lands. In tank bunds and porambokes, nothing is paid for the earth itself, and the cost is only two annas per cart-load (when the distance to be carted is about half a mile), for clearing the prickly-pear to get at the earth beneath, digging the earth, loading and carting it to the fields. The price per cart is becoming higher gradually owing to the increased wages. The soil under the prickly-pear bushes is of high manurial value as it is very largely composed of leaf-mould and other organic matter blown in by the agency of wind. Prickly-pear itself contains more than 60 per cent. of organic matter (Dr. Leather's analysis), and if such a substance is composted with the rich soil found under these bushes the manurial value will certainly be enhanced. Many of our soils are deficient in organic matter, and if a compost of prickly-pear and the soil found under it is made and applied, the result will be beneficial. By composting prickly-pear, ryots not only obtain manure but get rid of this pest which is at present a nuisance in many respects.

The following methods may be adopted for composting :—

(1) A trench 3′ to 4′ deep and 6′ broad of any required length may be dug and kept ready during the interval between the first and second monsoons. During rainy days when the ryots have not got busy work, prickly-pear may be cut, removed and filled in the trench and covered with soil that has been removed in

digging it. The top of the trench will sink after some days owing to the decay of the stuff and at this stage the soil from under the removed bushes may be dug and thrown on the top. In places having good rainfall, this will make a good compost within one year. If the thorns have not decomposed thoroughly, this may be left for another year when the thorns also will decompose.

(2) In regions of scanty rainfall, prickly-pear may be removed and heaped up in convenient mounds and allowed to dry up during season when ryots have enough leisure at their disposal. Dried bushes, grasses and other rubbish procurable in the vicinity may be spread over the heaps and set fire to. The thorny substance is partially burnt. At this stage the earth removed from under the bushes or from lands close by should be spread all over the heap which can then be left for some years until decomposition is complete. In three or four years, this will be fit for being carted to fields.

(3) If space is not available for the above, circular constructions similar to those used for grinding chunam should be made. *The prickly-pear is then thrown into this pit and ground by a* stone grinder just as chunam is ground. Owing to the large amount of water in the stems the plant, when the stuff is ground, is converted into a jelly-like substance within half an hour and the whole mass can be removed by mammuties and carried to places where compost is to be made. If this is filled in pits or covered with some earth, decomposition will easily set in. The thorns also will not stand erect but will lie flat and the nuisance they cause will be much reduced. In this case the manure will be ready within six to eight months.

Prickly-pear can also be used to serve other useful purposes than the one above referred to. The water obtained after boiling *prickly-pear for some time can be used as a drier in white-washes.* An ordinary pot or chatti is filled with prickly-pear cut into small pieces; as much water as the pot will hold is then added. The whole is boiled for about three hours and stirred during the process. When cool, the liquid is strained and added to separately prepared white- or colour-wash in the proportion of 1 to 150 or 160.

White-wash or colour-wash treated in this way becomes fast and does not rub off easily. In Indian houses this fast colour is a great advantage as it does not soil the clothing or body when the newly white-washed walls are touched.—[*The Indian Trade Journal.*]

MACHINE TREE-PLANTING.

The mechanical tree-planter put in operation in Wyoming County, N. Y., under the supervision of the Forest Service, transplants 10,000 to 15,000 forest-tree seedlings daily, and is stated to work in any land not too rough to be ploughed and harrowed. The machine, about as large as the common mowing machine, is drawn by two horses, while one man is required to drive and two more to handle the plants. A furrow is made for the trees, which can be placed at any required distance apart in the row and the place for dropping each one is indicated by an automatic device. The soil is pushed around the roots and firmly rolled by the metal-tyred wheels. Water and fertiliser are applied to the roots of each seedling by two special attachments, and another attachment marks the line for the next row. Considerable saving in cost is claimed, one man setting by hand an average of 1,200 to 1,500 plants per day.—[*Capital.*]

PLANTING OF EUCALYPTUS.

In the Report on the Government Botanical Gardens, Saharanpur, for the year ending 31st March 1916, we find the following note on the Eucalyptus plant :—"Continued attention has been given to this class of plants, specially in view of the interest that appears to be now shown by the Railway Board, who has suggested this class of plants for planting on waste lands belonging to Railways. The diverse conditions under which species of this family will grow, and the varied uses to which they can be put, make them all the more valuable and interesting for study and experiment. The main point is to ascertain which species will flourish under the very varied conditions to be met with in India. Only actual trials under such conditions will enable us to know this. For example, out of several species sent to Ajmer for trial by the Bombay, Baroda and Central India Railway, it has been found that the best to flourish is E. tereticornis, a species that has been supposed to do best in fairly moist or even wet soils, yet in

Ajmer it flourishes on dry sandy soils. Out of some trials on different conditions of soils on the Laksar-Hardwar branch of the Oudh and Rohilkhand Railway, the following has been reported to do best on :—A. *Dry or stony ground*—E. punctata. B. *On ordinary ground*—E. paniculata, melonophloia and microcorys. C. *On swampy ground*—E. rudis and robusta. Out of the 54 species under trial at Saharanpur, the relative positions are : good 19, fair 16, bad 18, as compared with 14, 28, 12 in the same order the year previously. This shows, as may be expected, that the 'Fair' will gradually be eliminated, resolving into either 'Good' or successful, and 'Bad' or failures ; when this is completed we shall then have an authentic record of the successes and failures of those that have been tried. At Dehra Dun the following species seem to be well established, *viz.*, E. bicolor, botryoides, microcorys, patentinervis (which is giving seed), rostrata, rudis (also seeding), saligna, and sideroxylon. It may be of value to note that of these E. bicolor, botryoides and sideroxylon are reckoned as failures at Saharanpur, which proves that it is impossible to judge a species by trial at one place alone. So far it may be said that the most successful species generally are E. citriodora, microcorys, obliqua, paniculata, punctata, robusta, rostrata and rudis. Of these E. microcorys, obliqua, punctata and rudis are comparatively new species to India, and perhaps the most successful of these is E. rudis, which has not only proved the most successful here, but also at Lucknow and Lahore. The following eight new species have been added this year, and will be subject to the same trials as the others, *viz.*, E. bosistoana, consideniana, corymbosa *var.* terminalis, exerta, maculata, pulverulenta, salmonophloia, and viminalis."—[*The Indian Trade Journal.*]

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WOOD FLOUR.

Wood flour is ground or milled wood that has been screened so as to remove coarse particles and also to give particles having some uniformity in size. Wood flour is usually sold at 40, 60 or 80 mesh, although one large foreign purchaser has the following specification for dynamite flour :—

20 per cent. must pass through an 80-mesh screen.

50 per cent. must pass through a 60-mesh screen

100 per cent. must pass through a 50-mesh screen.

The different properties of a good wood flour are: 1st, it must be white; 2nd, it must be light and fluffy; 3rd, it must be absorptive.

All industries in which wood flour is used (and these will be considered in greater detail later) require a white or very light cream-coloured flour, although absorptive qualities are demanded in a large degree only in dynamite flours. Colour and weight considerations, therefore, limit the species of wood which may be used to the white, light, non-resinous conifers and to the white, broad-leaved woods like aspen and poplar. Spruce, white pine, and poplar are the species most often used. The wood must be barked before grinding, and round wood, slabs (barked), and saw-dust free from bark may be used.

The grinding of the wood is performed in two distinct types of apparatus, either stone mills or steel burr roller mills. In Europe, particularly Scandinavia, where a great deal of wood flour is made, the stone mills seem to be used exclusively, and most of the early plants in this country use this type of mill. The stones are from 40 to 60 inches in diameter and only the lower stone is driven, the upper one being stationary. The mills are driven with water power turbines, since flour produced with other sources of power cannot compete with Norwegian flour ground by water power.

The wood, after barking, is first reduced to chips by means of the usual type of chipper or hog. These chips, along with a certain proportion of the screenings, are fed to the mills, which

are completely enclosed (with the exception of an opening at the top) with an iron or steel cover. Sufficient steam or water is added to prevent firing, and also to keep down the dust. The fine stuff from the mill is then drawn or blown through iron pipes or sheet metal ducts to the screening apparatus, which may be of several types, and which may be either bronze wire or silk bolting cloth, for both are used. After screening, the flour is packed either in compressed bales (the imported material comes in this way) or else is sacked with automatic sacking and weighing machinery.

Mills of the above type require from 45 to 50 horse-power per 24 hours per ton (from 1,200 to as high as 1,500 h.-p. hours per ton) of flour produced, the power requirement being about the same as in the production of mechanically ground wood-pulp.

Another type of mill was developed on the Pacific coast about twenty-five years ago and was designed specially to handle saw-dust as a raw material. This grinder consists of a number of pairs of corrugated chilled steel rolls which turn towards each other. One of the rolls rotates three times as fast as the other, thereby actually cutting the saw-dust which comes between them The slower roll has its corrugations arranged so that they form pockets to hold the dust, while the faster roll does the cutting. There are three stands of rolls, the corrugations being progressively finer on each stand.

The saw-dust is screened before reaching the first rolls, so as to remove slivers, small blocks, etc. It is then passed over a strong electric magnet to pick out any particles of iron or steel present, and is also screened through bolting cloth between each pair of rolls to remove material of suitable fineness. The production of wood flour from saw-dust in this type of mill requires only from 20 to 25 per cent. of the power required with the stone mills.

Before the war, Norwegian wood flour was delivered at our Atlantic ports for from $12·50 to $15 per ton, and domestic material sold in competition therewith. The domestic production is largely controlled by one concern, although mills are scattered

all over the country from Maine to California, wherever the combination of proper wood and water power is available.

The principal uses for wood flour are in the manufacture of dynamite, linoleum, artificial plastics and flooring, and as an inert absorbent in many industries.

A dynamite flour must be both white and highly absorptive. Since dynamite darkens with age, a light-coloured stick is indicative of fresh stock, and trade demands, therefore, require the use of a white flour. For this reason it would be practically impossible to introduce the use of a wood flour produced from any coloured woods. A good flour should be capable of making a 60 or 70 per cent. dynamite (60 or 70 per cent. of the total weight being nitroglycerine) without permitting leakage or exudation of nitroglycerine. It is possible to improve the absorptive qualities and power of a flour by mixing it with water, boiling it actively for a short time, and then drying, although this process, of course, increases the cost of production appreciably. For dynamite purposes, therefore, wood flour must be as white as possible, it must be absorptive, and must be of the proper weight not only because the size of stick and number of sticks per box is standard, but also because too much flour cannot be used because it would disturb the carbon and oxygen balance in the explosive.

In the manufacture of linoleum, wood flour is used exclusively in the production of goods belonging to the inlaid class, either "granulated inlaid" or "straight-line." Cork linoleum is always dark, either the natural brown or dark red or green. Patterns are printed on cork linoleum, but the pattern soon wears off, leaving the dark base. For the production of inlaid goods, in which the pattern goes clear through the piece to the burlap backing, a white base is naturally necessary, not only to furnish a white background where desired, but also to permit of dyeing to any colour. For this reason a flour as white as possible is desirable.

For composition flooring, plastics, oatmeal paper, etc., the principal requirement is light colour, although in some cases certain species are necessary, as in the production of artificial bates for tanneries. The latter consists of a mixture of wood flour,

ammonium chloride and certain animal extracts, which are absorbed by the wood flour. Here again the trade demands a light-coloured product, and it has been found that flour from broad-leaved woods like poplar will cause a discoloration on storage, so that only flour from spruce or white pine may be used.—[*Timber Trades Journal.*]

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THE COMMERCIAL SIDE OF FOREST WORK IN INDIA.

PART II.

BY R. S. PEARSON, I.F.S., FOREST ECONOMIST.

There appeared in the March 1916 number of the *Indian Forester* an article with the above title, which led to the production of an excellent article on the same subject in *Indian Engineering* of the 15th April. Since then the *Pioneer* has published three interesting articles on the same subject, ending with one in its issue of the 9th September 1916. All these articles sing approximately the same song, the words of which concern the employment of business men to look after the commercial affairs of the Forest Department.

If we accept the principles laid down in the above-mentioned articles and wish to develop the resources of the State forests to their utmost, what further difficulties have we to face? They are without doubt many, though by no means insurmountable. To begin with, we must accept the fact that Indian capital is extremely shy of new ventures in connection with forest industries; other

factors which have to be considered are the ever-increasing demands of silviculture and management; then, again, cheaper and better methods of extraction must be devised; seasoning and conversion of the timber after extraction are all important points; and lastly, there exists no market for certain kinds of timber. These five factors, not including want of staff—a question which was fully, discussed in the last article are primarily responsible for the slow development of the commercial side of the Forest Department in India. I propose to discuss each in detail.

It is well known that financiers look askance on new enterprises in India, which fall outside the established industries of the country, and this is especially the case with new enterprises connected with forest products.

This state of affairs is not to be wondered at as forest areas and products are often vague unknown quantities to them, while they not infrequently become further befogged and suspicious of the whole business by the promoters of a venture bombarding them with scientific names of the timbers or products which they wish to exploit. Again, owing to the nature of all work in the forest, when first undertaken, it must necessarily be of a somewhat speculative nature, entailing a lot of spade work before definite facts can be established, which obviously costs money, and this is another reason why capitalists do not freely undertake such ventures. However, we have to accept these facts and consider ways and means to overcome the difficulties. The line of least resistance is for Government to give a lead either by starting the industry departmentally, on a modest scale, and thus taking all responsibility themselves, or by subsidising a firm to start and carry on the industry for a specified period, after which the firm may, according to previous arrangements, have the right to buy out Government and only pay royalty on the raw produce. It is thought that such a procedure would only be applicable when the industry presented special difficulties and when it could not be expected to pay at once. In the case of an industry about which more is known, it might only be found necessary to give an enterprising company an advantageous lease for a period of years in

order to induce them to undertake the business. Then, again there is the question of a Forest Loan, which, as pointed out by the *Pioneer*, was suggested by a long-sighted official some years ago in order to overcome the above-mentioned difficulties. At the same time it must be remembered that such loans could only be considered in connection with a proposition entailing large sums of money. While outlining the above proposals, which, were they accepted, would in some cases involve departmental working, nothing has been said as to how the Forest Officer could possibly undertake the work, for the reason that it is taken for granted from the first that a staff of commercial men would be appointed by Government for the purpose.

This brings us to the second factor, namely, the safe-guarding of the silvicultural requirements of our forests, which go hand in hand with exploitation in its various forms. During recent years those who have studied the progress of the technical working of the State forests, will have heard much about more intense management, closer tending of the crop and the introduction of more uniform methods of working. It is certain—and most foresters will, I feel sure, agree with me—that we are only at the very commencement of this movement in the right direction and that the tendency in the future will be to carry the process of concentrated working to, at present, unthought-of limits.

Now what does more intense management, in practice, mean? In the past we have exploited mature or over-mature saleable species of timber, a certain but very limited number of doubtfully saleable species, while only in the more intensely worked forests a small percentage of the so-called "Inferior" Species have been either girdled or cut to favour the advance growth of better species of trees. On the introduction of more concentrated methods of working we can no longer contemplate leaving all the partially-mature and over-mature trees of the "Auxiliary" Species in our forests, as, were they not removed, the percentage of the better species in the future crop would necessarily suffer at their expense. Some of them must, therefore, come out in accordance with the silvicultural requirements of the whole crop, and the system of

management adopted. This condition of affairs at once brings us to the question of finding a market for such timber, otherwise how will it be possible to work the forests on sound principles? We have heard much about uniform methods of working, which entail the sacrifice of a certain percentage of the "Auxiliary" Species though no definite proposals have been propounded as to how to utilize the less valuable timbers.

The next difficulty mentioned concerns engineering problems, which are bound up with extraction in its many forms. The most enthusiastic Forester could not claim that our methods of extraction are perfect, though much has been done to improve matters in recent years. The authorities fully recognise the necessity of improving communications, and one has only to compare the amount spent by Local Governments in recent years with the amount spent ten or fifteen years ago to see that this is the case, while at least two Local Governments have appointed Forest Engineers of their own to solve knotty problems, which obviously is a most wise procedure. But this is not enough. The forests are very extensive and the problems many, necessitating a much more liberal policy in this direction. Consider only the point as to finding markets for the "Auxiliary" timbers which have to come out for silvicultural and other reasons. It is obvious that in this direction we cannot hope to succeed unless we can place such timbers on the markets at relatively low rates, and to do so will require every mechanical device available. Again, consider our best timber. We can exploit and sell it at a profit, but why not enhance that profit by more up-to-date methods of extraction? It would be quite easy to cite instances in support of this point, and the Forest Officers concerned know of them only too well, but are powerless to act either for want of staff, time or funds or a combination of all three factors. The first step therefore, if a proper normal development is to take place, is to improve the methods of extraction, which can best be accomplished by trained Engineers.

The conversion and seasoning of timber has been mentioned as all-important. We are regrettably behindhand in India in

the science of seasoning timber, though so much depends on it. It is a tiresome and lengthy business to carry out, while, if carried out artificially, it may become somewhat expensive and yet it is of vital importance when attempting to bring new kinds of timber on the market. Hand in hand with the seasoning of timber goes the proper conversion of the same. Who will buy rafters which are split and warped and not cut to uniform sizes and to the required dimensions, however good the quality of the timber may be. At present want of saw-mills and care in seasoning forces us to put up much of our timber for sale in the log. This is no great disadvantage in the case of such timbers as Teak, Sal, Blackwood and others of the well-recognised timbers but results in the less well known timbers not finding a sale which, on the other hand, would sell readily were they carefully seasoned and well sawn to size. Too much importance can scarcely be attached to these two points if we wish to find markets for the "Auxiliary" timbers.

Another side to the question, which was dealt with in the last article, and which depends on proper seasoning and conversion, is the *supply of timber for trial as to its suitability for* new purposes. Over and over again have timbers been passed as unsuitable for a stated purpose simply because the timber was submitted to a firm in a green or otherwise defective state.

To overcome these difficulties we must introduce permanent, semi-portable or portable saw-mills in suitable localities which may be run departmentally or otherwise but which must, in any case, be run in conjunction with natural or artificial seasoning and possibly in connection with such industries as turnery, involving the manufacturing of toys, bobbins, or carpentery, including box-making, joinery, wheel-wright's work, cooperage, etc. If such schemes were contemplated the agency of control should obviously not be the Forest Officer but commercial industrial experts.

And lastly, assuming that we have at our disposal seasoned well-sawn timber of "Auxiliary" Species not at present on the market, how are we to bring it to the notice of the public? In many cases the fact that it is properly cut and seasoned will find

it a ready sale, while, in other instances, more will have to be done. In some instances, the commercial staff will be able to place trial consignments of timber with interested firms and so introduce a given timber on the market. Then, again, numerous enquiries are made of the Forest Research Officers, who are in a position to test the timber for its mechanical strength and other qualities and so are able to certify to its use for special purposes, and thus introduce it on the market. If we accept the above position of affairs, namely, that by mutual co-operation of the Forest Officer, the Commercial Staff and Research Officers we can by degrees find uses for the timbers at present not on the market, we shall have to establish a limited number of timber depôts all over the country, one or more in each province, according to the outturn and locality, and for this reason that if a small trial consignment of timber is passed as suitable for a given purpose, it must, on demand, be at once backed by a larger consignment, otherwise the whole enterprise fizzes out and dies a premature death. It would be hard to say whether more failures have resulted by submitting unseasoned or faulty timber to be tested or by inability to comply with orders, for timber, of which small samples had previously been submitted and passed as suitable for a definite purpose.

The above proposals naturally fall under two heads: one, the question of extra staff, the other, ways and means of exploiting the Forest Product. To summarize these proposals under the first head, they involve a reconstitution of the Forest Staff, into (i) Forest Officers in charge of the management and protection of the forests, (ii) a Forest Engineering Staff in charge of exploitation and communications, and (iii) a Forest Commercial Staff in charge of sales, development of new forest industries, and the finding of new markets for the timber, and (iv) a Staff of Research Officers. The first and last group of officers are already available, though not in sufficient numbers, while the Engineering and Commercial Staff are practically non-existent.

The proposals coming under the second heading deal with methods of exploiting the forest produce. State aid is advocated with regard to the introduction of certain large industries, where

private enterprise is not forthcoming. To meet the silvicultural requirements and, at the same time, to find new markets for certain timbers, a strong policy is advocated in the direction of erecting saw-mills *cum* seasoning plants so as to give the timber every chance of fulfilling the requirements of the public and of being presented for sale in a suitable form and in good condition. And lastly, the establishment of timber depôts, managed by the State to enable it to control the market, supply extraordinary demands which may arise for timber for new industries and to accustom the public to the use of new varieties of timber. Were such proposals given effect to, the benefits thereof would probably not be felt at once, though in time there can be little doubt that they would yield handsome revenues.

Nothing has been said in this article about the development of the minor products obtainable from forests, which deserve a separate article to themselves.

TEAK TAUNGYA PLANTATIONS IN THE HENZADA-MAUBIN DIVISION.

BY C. W. ALLAN, EXTRA-DEPUTY CONSERVATOR OF FORESTS, BURMA.

Although the planting of teak by "taungyas" was stopped in Burma some years ago, it was continued in the Henzada Division up to the year 1914, as it was found that this was the only way of regenerating teak in the Kyangin Reserve, in which large tracts were covered with almost pure *Myin* bamboo (*Dendrocalamus strictus*) owing to the forest having been under "taungya" cultivation till the year 1902 when it was constituted a reserve. In years previous to 1909 planting was done in lines 12′ × 3′, and it was found that it took some ten years for the plants to form a leaf-canopy and to kill the grass, the "kaing" and "kyu" grasses coming up very thick and strong in the plantations. This was represented to the Conservator when he inspected the Division in the year 1911 and permission was obtained to plant in lines 6′ × 4′. With this spacing the plants form a leaf-canopy

in the third year and at once begin to kill down the grass, and the plants shoot up very much faster. "Taungya" planting in this Division as in others is done by villagers who prefer this method of cultivation to permanent rice cultivation chiefly because they have no paddy land.

Areas for the year's taungyas are selected by the Divisional Forest Officer as a rule in November and December. The *ya* cutters start cutting the forest which has been marked out in plots (*yas*) by each licensee about the middle of January and the cutting continues till the end of March or even later if the plots have not been joined up. The bamboos and trees cut are laid flush on the ground. After the cutting has been completed, each *ya* cutter prepares a number of stakes to put down in lines for the planting. Then a few days before it is time to burn the *yas*, which is generally on the full moon of April, a fire-trace is cleared round the entire area to be burnt and on the appointed day all the men, women and children connected with the *ya* cutters are collected, as well as all the coolies employed in forest works in the neighbourhood, also as many subordinates as can be spared for the work. The area is then surrounded and each person provides him or herself with a leafy branch to beat out fires. Then, at a given signal, the fires are started from all round, the traces having been cleared some one hundred yards or so from the cut *yas*. The fires then burn slowly till they get to the cut *ya* when the flames shoot up and are fanned on by the strong breeze created by the burning. Soon the whole of the cut portion is on fire and the flames are leaping up to thirty feet or more in height and the exploding of the dry bamboos is like the firing of guns and puts one in mind of a battle. In a couple of hours or so the whole area has been burnt and all that remains are the thicker trees that have not had time to dry. Watchers keep guard round the burnt area all night to see that burning stumps do not blaze up and send sparks into the unburnt area.

The next day and for some days following, the *ya* cutters with their families collect all the unburnt stuff into heaps and

burn it, and when the burning has been completed, the pegs are laid out in lines 6′ × 4′ by means of strings and strips of split bamboo. When this has been done, the seed is put down at once. This is finished by the first week in May, so that by the time the rains break the seed is all on the ground. The seed is not covered with earth. It is merely put on the surface at the stake. If the ground is sloping, a level place is dug out and the seed put down, so that it will not be washed away. Nurseries are also made in different parts of the *ya* to fill up blanks later on.

The rains generally break about the first week in May, sometimes they are earlier and sometimes later. After the first fortnight of rain there is generally a break. The seed by this time has had a thorough good soaking. Then the sun comes out and a damp heat results—just what the seeds want for good germination. When the break is over and the rain comes on again, the seeds soon begin to sprout and by the end of June most of the young seedlings have a healthy pair of leaves. After this, the *ya* cutter has to look out for failures and as they occur, he puts in a seedling from the nurseries. The plants need to be kept clear, especially in parts over which peas and beans have been sown, as they are apt to choke the young teak plants. For this reason the sowing of beans should be discouraged as much as possible. Teak comes up best with a crop of Indian corn.

About the end of December or beginning of January, by which time the crop of vegetables has been cleared off the ground, the *ya* cutters are put on to clearing the lines of plants and replacing all stakes that have been lost. When this work has been completed a day is fixed for the counting, when as many subordinates as can be spared from other works are collected, also a number of the Indian coolies who are employed on clearing fire-lines and roads. Most of these Indian coolies are men who have worked in the Division for the past eight years and so know what is required of them.

A line of some thirty or forty men is thus formed with a forest subordinate behind every five or six men to see that the counting is done properly. Each man is given a strip of split

bamboo cut very thin and of any length (Burmese *hneecho*) and they are instructed to pick up the stake at each living plant and to break or dent the strip of bamboo with the thumb nail for each blank and at the same time to call out *mara* in Hindustani or *athè* in Burmese. The line is then ordered to go, the subordinates at each end of the line seeing that it is kept straight. If a part of the line is found to be advancing too far ahead, a halt is called for that part till the line gets straight again, when it is allowed to proceed. When the line comes to the end of the *ya* the men deposit their stakes, which are then collected and taken to the hut in the *ya* or to some convenient place near by. The line then forms up again, each man taking a new row, and when the men are in position they are told to go again till they finish the next line, and so on till the *ya* is finished. The Gazetted Officer who superintends the counting follows the line, going from end to end to see that the work is being done properly. When the pegs in the *ya* have all been collected, men are put on to count them and lay them out in rows of bundles of one hundred pegs. At the same time all the *hnees* are handed over to one or two men who do the counting of the dead plants. When the counting of the bundles of stakes and the *hneechos* has been completed, the *ya* cutter is informed of the number of living and dead plants in his *ya* and the amount that is due to him. This is entered in a book, and the area also which is calculated at 1,210 plants living and dead to the acre. In this way from fifty to eighty acres a day or more can be counted.

Plate 50, Fig. 1, shows part of the *ya* after the counting of the plants had been completed and also, in the background, the area to be cut for the following year's plantations.

The size of the plants, when counted in December and January, varies from six inches to three feet six inches in height. (See Fig. 2 of the same plate.)

After the counting has been completed, the plantation wants no more done to it till the June of the following year, when it is given a first weeding. In September or October it is given a second weeding.

Fig. 1.

Fig. 2.

Photo.-Mech'l. Dep't. Thomason College, Roorkee.

Teak Taungya Plantations in the Henzada-Maubin Division.

Fig. 3.

Fig. 4.

Photo.-Mech'l. Dept., Thomason College, Roorkee.

Teak Taungya Plantations in the Henzada-Maubin Division.

No further weeding or cleaning is necessary till the plants are four or five years old, when, if the grass has not been killed down and bamboos have come up, a cleaning may be necessary, but as a rule the plants have got their heads well over the grass by the time they are four years old. Plate 51, Fig. 3, shows a plantation of 1912 photographed in December 1914, average girth of plants 8″, average height 17′. Fig. 4 of the same plate shows the density of the 1911 plantation photographed in December 1914.

The "taungya" cultivators are paid at the rate of one rupee per hundred living plants at the time of counting. The cultivator of an average *ya* of, say, 4·5 acres earns about Rs. 50 for the planting and the sale of his vegetable cereal crop brings him in another Rs. 60 to Rs. 80 or so. The crops cultivated are rice, Indian corn, sessamum cotton, chillies, sorrel, beans, gourds of kinds and brinjals, also sweet potatoes. The whole family of the *ya* cutter lives in the *ya* till all the crops have been gathered in, which is towards the end of December. The *ya* cutters supplement their income during the rains by collecting and selling bamboos, bamboo shoots, mushrooms and jungle herbs. They also trap deer, pig, jungle and civet cats, iguanas and ground lizards.

THE ROAD DRAG.

BY A. J. S. BUTTERWICK, EXTRA ASSISTANT CONSERVATOR OF FORESTS, BURMA.

1. *Introduction.*—This contrivance is being used with great success by the Public Works Department in this district for their roads, and the following information is now given in the hope that it may prove useful in the construction and maintenance of forest cart-roads. The road drag was first introduced by the Agricultural Department of the United States of America, and the writer is indebted to Bulletin No. 597 (Farmers) of 7th July 1914, issued by that Department, for most of the information given below.

2. *Purpose of the Drag.*—"The drag is a simple and inexpensive device for maintaining certain types of roads, which, when wet, become rutted under traffic and which become firm on drying

out. It is also well adapted for producing a smooth and uniform surface on newly-constructed roads in which the material used for surfacing is earthy gravel, or some similar material. When the construction of the drag is discussed later, however, it will be obvious that it is essentially a maintenance implement and that its use in construction is distinctly secondary. It will also be apparent that roads which are very rocky or very sandy cannot be materially improved by its use.

" Properly used, at the right time, the road drag performs four distinct offices. First, by moving at an angle to the travelled way it tends to produce or preserve a crowned cross-section. Second, if used when the material of the surface is not compact and hard, it tends to reduce ruts and other irregularities in the road, by moving material from points which are relatively high, to those which are relatively low. Third, when used after rain, it accelerates the drying out of the road, by spreading out puddles of water and thus increasing the surface exposed to evaporation. Fourth, if the surface material is in a slightly plastic state, dragging smears over and partially seals the so called pores which naturally occur in earthy material, and thus makes the road surface more or less impervious to water. The advantage of this smearing action of the drag will be more readily understood if a sample of the ordinary earth is examined under a magnifying glass. Such an examination will show that the earth closely resembles a sponge or honey-comb in structure and the desirability of closing the open pores will be readily apparent.

" If used improperly or at the wrong time, the drag may do actual injury to a road Dragging a very dry road, for example, serves to increase the quantity of dust and may do additional damage by destroying the seal produced during previous dragging. If, on the other hand, the road is very wet and muddy, the irregularities in the surface are likely to be increased rather than diminished by dragging. '

In the Forest Department the drag will not be of much use on a hard surface, like laterite soil nor on roads going along the beds of streams.

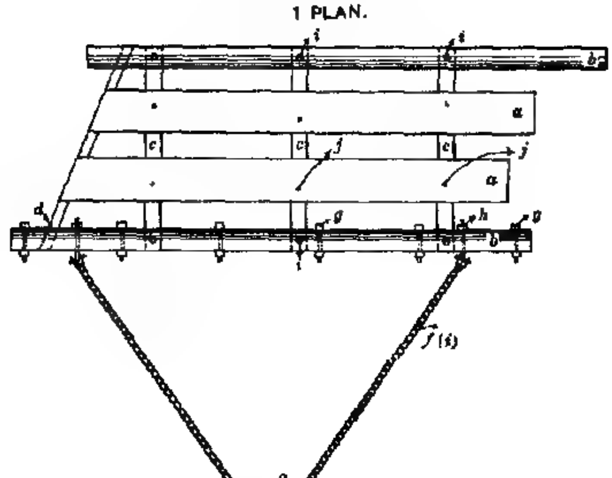
SKETCH

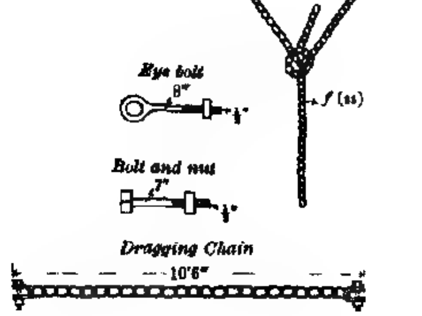
OF

ROAD DRAG.

Scale—1 Inch = 3 Feet ($\frac{1}{36}$).

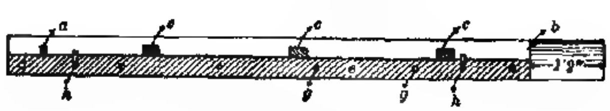
1 PLAN.





a a Planks 7' × 8'' × 1''
b b Runners 8' × 8' × 4''
c c Struts 3'2'' × 3' × 3''
d Diagonal strut 3½' × 1½' × 1½''
e Iron strap 8' × 5¾'' × ¼'
f (*i*) Dragging chain 10'6'' in length
f (*ii*) „ „ 10'6' ,
g Bolt and nut 7'' × ½''
h Eye bolt 8'' × ½'
i i Trenails
j j Wire nails

2 FRONT ELEVATION (DRAGGING CHAIN NOT SHOWN).



3 SIDE ELEVATION (DRAGGING CHAIN NOT SHOWN).

3. *Construction.*—The drag may be made of iron, reinforced concrete or timber, both in the round and squared. The last named is the cheapest and most efficient and the three drawings in Plate 52 give the plan and two elevations of the drag being used at present by the Public Works Department. It can be very easily and cheaply repaired. It will be seen that it consists first of (*b*) two long runners 8′ × 8′ × 4″. These should lie parallel to each other, but one should project about 12″—16′ beyond the other. Their extremes, therefore, will form a rhomboid. They are bound to each other by (*c*) four struts, which are tennoned into the runners, three being at right angles and the fourth (*d*) at an angle of about 68°. Nailed on to these are (*a*) two planks 7′ × 8″ × 1′ placed parallel to the two runners. On these the driver can stand when working the drag. To provide a cutting edge, an iron strap (*e*) 8′ × 3¾′ × ¼′ is bolted on to the lower half of the face of the front runner The drag is drawn by means of (*f*) an iron or steel chain 8′—10′6′ long. The links of this should be made of ¾′ iron or ⅜″ steel. This chain is attached to the front runner by means of two iron eye or hook bolts (*h*). On to this chain is either a movable link or another chain (*f*) which clutches on to the yoke carried by the bullocks or buffaloes. It will be seen that the moving of this link or second chain more or less from the middle of the first chain will cause the drag to skew in a corresponding degree. The drag should be made of a hard durable seasoned wood such as Pyinkado (*Xylia dolabriformis*), Padauk (*Pterocarpus macrocarpus*), or Ingyin (*Pentacme suavis*). The cost of the drag in Pyinmana, including all ironwork, comes to Rs. 30.

4. *How to use the drag.*—"The principal factor in successfully operating a properly constructed road drag, provided that the condition of the road is favourable, is skill on the part of the operator. Such skill can be obtained only by intelligent experience in the use of the drag and no rules can be laid down which would enable an inexperienced operator to attain first class results. The following suggestions are intended, therefore, to serve rather as a guide to the judgment than as a criterion to be implicitly

followed. Under ordinary circumstances the position of the hitching link on the draw chain should be such that the runners will make an angle of from 60°—75° with the centre line of the road, or, in other words, a skew angle of from 15° to 30°. It is apparent that by shifting the position of the hitching link the angle of skew may be increased or diminished as the conditions require. When dragging immediately over ruts or down the centre of the road after the sides have been dragged, it is usually preferable to have the hitching link at the centre of the chain and to run the drag without the skew. When the principal purpose of the dragging is to increase the crown of the road, the drag should be sufficiently skewed to discharge all material as rapidly as it is collected on the runners. On the other hand, if depressions occur on the road surface, the skew may perhaps be advantageously reduced to a minimum, thus enabling the operator to deposit the material, which collects in front of the runners, at such points as he desires by lifting or otherwise manipulating the drag. Many other examples of conditions which require modifications in the angle of skew might easily be cited, but these will readily suggest themselves to an intelligent operator as his experience increases.

"The length of hitch is another very important consideration in operating a road drag. In the drawings given before the second draw chain may be readily taken up or let out and the length of hitch thus increased or diminished as desired. It is impracticable to prescribe even an approximate rule for fixing the length of hitch, because it is materially affected by the height of the team and the arrangement of the harness, as well as by the condition of the road surface. Experience will soon teach the operator, however, when to shorten the hitch in order to lessen the amount of cutting done by the front runner and when to lengthen it in order to produce the opposite effect. When the road surface is sufficiently hard, or the amount of material which it is desired to have the drag move is sufficient to warrant the operator standing upon the drag, while it is in operation, he can greatly facilitate its work by shifting his weight at proper times.

For example, if it is desired to have the drag discharge more rapidly, the operator should move towards the discharge end of the runners. This will cause the ditch end of the runners to swing forward and thus increase the skew angle of the drag. The operator may, of course, produce the opposite effect by moving his weight in the opposite direction In the same way, he can partially control the amount of cutting which the drag does by shifting his weight backward or forward as the case may be. An intelligent and interested operator will soon learn many simple ways by means of which he can easily control the different features of the work which a drag performs and he will also learn to utilise effectively every effort which his team exerts. Unskilled or indifferent operators, on the other hand, may do actual injury to a road by dragging it in an improper way and they generally waste a large part of the work which their teams perform. Cases are not infrequently observed in which no care whatever has been exercised to see that the team is properly hitched to the drag, or to determine when the operator should ride and when walk. Very often the operator seems to think that the drag is, or at least ought to be, an automatic device and that his function is merely to drive and ride. It is almost needless to say that under such conditions as these, the road drag usually proves a failure."

5. *When to use the drag.*—" It is fully as important that a road be dragged at the right time, as it is that the dragging be properly done. Furthermore, the difficulties involved in prescribing definite rules for determining when dragging should be done are equally as great as those already encountered in attempting to define how it should be done. Only very general statements concerning this feature of the work can properly be made here, and much must be left to the experienced judgment of those who decide when the dragging of any particular road is to be started and when it is to be stopped.

" The rule frequently cited, that all earth roads should be dragged immediately after rain, is, in many cases, entirely impracticable, and is also very misleading because of the conditions which it fails

to contemplate. It is true that there are many road surfaces composed of earth or earthly material, which do not become very muddy under traffic, even during long rainy seasons; and, since such surfaces usually tend to harden very rapidly as soon as the weather clears up, it may be desirable to drag roads of this kind immediately after a shower of rain. Such roads, however, would not ordinarily need to be dragged after every rain, because of the strong tendency that they naturally possess of maintaining their shape. On the other hand, many varieties of clay and soil tend to become very muddy under only light traffic after very moderate rain, and it is evident that roads constructed of such materials could not *always be successfully dragged immediately after a shower of rain.* Sometimes, in fact it may be necessary to wait until several consecutive clear days have elapsed after a long rainy spell before the road has sufficiently dried out to keep ruts from forming almost as rapidly as they can be filled by dragging. In many cases of this kind, however, it is possible greatly to improve the power of the road to resist the destructive action of traffic during wet weather by repeatedly dragging it at the proper time. Well-constructed loam roads should not often become muddy after they are once well compacted. They may become seriously rutted, however, under heavy traffic during rainy weather, and are almost sure to need dragging several times each year. Such roads should ordinarily be dragged as soon after a shower of rain as practicable, as otherwise the surface soon becomes dry and hard so that it is necessary to do considerably more dragging in order to fill the ruts. Furthermore, the material which the drag moves will not compact readily unless it contains a considerable amount of moisture.

"Gravel roads can be effectively maintained with a road drag only when the gravel composing the surface is pure-grained and contains a considerable quantity of clay or earth. Gravel road surfaces, in which this condition prevails, not infrequently get badly out of shape during wet weather and may sometimes require considerably more attention than other well-constructed roads. The time for dragging gravel roads is unquestionably while they are wet. In fact, the best results are sometimes obtained by

The "Road Drag" in use in Pyinmana Division.

1 Drag held up on edge to show its construction.

2. Drag being used. Note the ridge of loose earth left at the discharge, along the middle of the road.

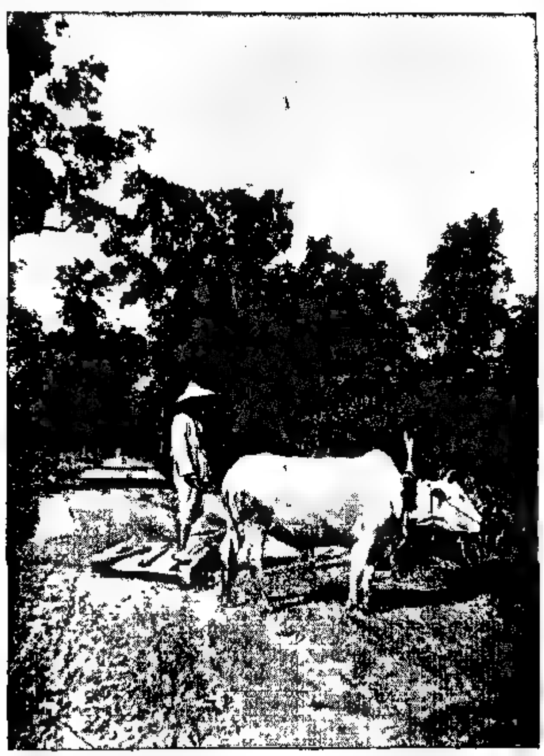


Photo.-Mechl. Dept., Thomason College, Roorkee.

3. Drag being turned on its backward journey.

doing the dragging after the road has become thoroughly soaked and while it is still raining.

"In general, it may be said that the best time to drag any type of road is when the material composing the surface contains sufficient moisture to compact readily after it has been moved by the drag and is not sufficiently wet for the traffic following the drag to produce mud."

In Pyinmana where the average rainfall is about 50 inches per annum, dragging is done from the 1st July to the 31st October. It is believed that orders have been given that the dragging is not to be done during a heavy shower of rain.

6. *Cost of dragging.* -This being the first year in which the Public Works Department has used the drag, no information can be obtained as to the cost of its use. In America, too, in spite of the fact that road drags have been widely used there for some time, no reliable data as to its working cost is available. This cost will necessarily vary according to the locality, climatic conditions, labour available, and traffic conditions of each place and no general deductions can be given. It has, however, been definitely found in America that "no cheaper method than dragging has ever been devised for maintaining those types of roads for which the drag is adapted." In one country, in the United States, the cost per mile for dragging an earth road eight miles long came to about Rs. 11. In Pyinmana, the following is the way the drag is being used. All very deep ruts and hollows are first filled up by coolies, side drains are made, and the road is roughly cambered. The drag is then brought on. It is worked by a pair of bullocks or buffaloes harnessed on to a yoke. These animals are hired from one of the neighbouring villages. They work in the morning and in the evening and cost about Rs. 40 per mensem. The drag is at present being used on the worst parts of the road only. In the writer's estimate one drag can easily be utilized for eight miles of road. The drag need not travel the whole distance in one day, but can, for example, do the first mile for a week, then the second for the next week and so on until after finishing the eighth mile in the eighth week, it will return to the first mile and work on that again

for a week. As the drag can be worked for four months in the year (from July to October) or roughly sixteen weeks, each of the eight miles of road will be repaired for two full weeks. Taking the cost at Rs. 40 per mensem and the annual working period for four months, the total cost per year for the eight miles of road will come to Rs. 160 or Rs. 20 per mile. This will only be for the first one to three years, as after that time, the roads should be so well improved and consolidated that only the bad portions need be attended to in future years and the drag could then serve a length of over 20 miles of road. It is recognized that a certain amount of cutting, levelling and filling up will, in any case, have to be done by extra coolies. If, however, the road has been aligned and drained properly in the first instance, the cost of this extra labour will be very small. Labour will always be easily available as the job being a comfortable one, appeals to Burmans. Also, as the drag is about 2 cwt. in weight, its dragging does not entail much of a strain on the bullocks or buffaloes.

Conclusion.—To summarize a few of the principal points which have been explained at length above:

(*a*) "The road drag is the simplest and least expensive contrivance" yet devised for keeping the surfaces of roads in good repair. The drag itself is also easily repaired.

(*b*) It can be used for constructional purposes, inasmuch as it will dress the surface of the made road, but it is essentially a maintenance instrument.

(*c*) It can, however, only be used on unmetalled roads, and these too must not be very hard such as those on a laterite soil or very loose such as those along the sandy beds of streams.

(*d*) To work the drag successfully, it is a ***sine qua non*** that the operator should endeavour to make himself *au fait* with the instrument. If he simply drives and does not work it, his work may do more harm than good

(*e*) The time to use the drag profitably will vary in different localities and under different conditions. It may, however, be here laid down that "the working time should be when the material composing the road surface is sufficiently moist to compact readily under traffic after it has been moved by the drag and does not contain sufficient moisture for the traffic following the drag to produce mud." In Pyinmana, the working season is from the 1st July to the 31st October of each year.

(*f*) The cost of working the drag will vary in different places. It is estimated that for the first year of use, a drag can be easily employed on a length of eight miles of road. This will give each mile a dragging for two weeks (not consecutively) per year and will cost about Rs. 20 per mile. After the first one to three years, when the roads have been improved and consolidated by the dragging, the instrument can be used on the bad portions only and will therefore serve over twenty miles of road in one working season. This will reduce the cost appreciably.

ARBORICULTURE.

II.—Grass under Trees.

BY F. TRAFFORD, I.F.S.

[*Part I on "The Mound and Pit Method of Planting" appeared in May* 1916.]

A series of experiments conducted at the Duke of Bedford's fruit farm at Woburn over a period of sixteen years demonstrated beyond all doubt that when grass is allowed to grow on the soil in which trees are cultivated it not only checks growth but actually poisons the roots and may even kill the trees outright. These effects were found to be due to a poisonous substance produced by the grass roots and not to soil impoverishment. A note published in the Journal of Forestry for July on the growth of young ash trees in grass land at Oxford arrives at similar conclusions. In

March 1910, 120 young ash trees were planted at three feet intervals. The area was divided into two equal portions, one being sown with grasses and clover and the other kept free. The growth of the trees on the grassed land is found to be poor in comparison with that of the trees on the bare land.

The same effects can be traced in India in connection with the growth of trees.

I have in mind an instance of a coniferous plantation in India, which for years made little or no apparent progress; a time came, however, when the lower side branches met and killed the grass between them, the result was an extraordinary spurt in the growth of the plants.

Tea planters are very much alive to the benefits conferred by frequent hoeing and no grass is ever found in properly kept tea-gardens in India.

Road-side trees when they are considered to be out of reach of damage and drought are, as far as their roots are concerned usually allowed to struggle on without further assistance. There is no doubt, however, that the hoeing up of the grass particularly during the rainy season would help the growth of such trees especially in the pole stage.

One of the main difficulties confronting a Forest Officer is that pertaining to grass. *Heavy grazing does not kill it and grazing is* of itself injurious to tree-growth on account of the way in which the feet of cattle consolidate and so prevent the aeration of the upper layer of soil. If the grass is allowed to grow, it is a source of danger from fire, and if such areas are protected from fire the débris produced by the dying down of the grass annually not only offers a considerable barrier to the seed reaching the ground but undoubtedly forms the worst possible medium for the germination and growth of the young seedlings in the first instance.

Plantations have frequently proved failures owing to the fact that they have been expected to fend for themselves at too early an age. A plantation is started and kept weeded for some four or five years, the trees are then considered sufficiently well established to cope with the grass because they are tall enough

not to be smothered by it. The factor of poisoning not having been taken into consideration, the young saplings make little progress, many die out and the plantation is written down a failure.

The constant uprooting of all grass until such time as the trees composing a plantation have killed it out is undoubtedly a formidable undertaking and would ordinarily put the formation of plantations outside the sphere of practical forestry. Where the soil is fairly good, resource may be, and is frequently had to agri-silviculture. In many places there is sufficient humus in the soil to ensure a short rotation of field crops after which the land lies fallow. There should be no great difficulty in getting up a fairly valuable crop of timber trees during the period the soil is being cultivated. The next step is either the opening of the fallow land to grazing or allowing grass to come in.

It may be noticed that when cultivation ceases the growth of the plantation does not continue to flourish.

This is due in part to the injurious effect on the aeration of the upper layer of soil produced by the feet of cattle. That this is not the main factor, however, is proved by those instances in which the grass has been preserved as a source of fodder for stall feeding. Here the growth of trees is no better and some other cause must be looked for. It may be presumed with a fair amount of certainty that the poison exuded by the roots of grass is responsible for the subsequently stunted appearance presented by the tree-growth. The remedy for this must be looked for in the substitution of some form of perennially herbaceous or woody undergrowth to take the place of grass. The selection of the species must depend on the climate and local conditions generally, and there should be no difficulty in finding the antidote.

In a moist climate *Macaranga* sp. is a wonderful tree for coming up in grass and killing it out. It is comparatively short-lived, and as it has a very soft wood it can easily be prevented from suppressing the principal species. Sunn *(Crotalaria)* comes up very densely and would kill any grass. Saplings should be over six feet in height however to compete with it.

Strobilanthes sp. might be tried on hilly ground, and there are many hardy species of herbaceous perennials such as species of *Cæsalpinea* which would form a sufficiently dense carpet to kill out grass. *Lantana*, though probably effective where it can be readily controlled in small plantations surrounded by cultivation, can hardly be recommended for general use in forest areas. In fact any hardy gregarious species would have to be carefully watched that it did not get out of hand. *Macaranga* sp. abovementioned, once used as a nurse for Sal, earned a very bad reputation in that owing to oversight it was allowed to suppress the very trees it was intended to foster; as in the case of many remedies, a good servant became a bad master. Neglect in one rainy season alone, in restraining the exuberant growth of the foster parent, may undermine the work of years. Frequent changes of Divisional and Range Officers are detrimental to artificial reproduction. In the stress of assimilating the strange conditions of a somewhat unwieldy *entourage* a new Forest Officer may very well overlook experimental cultural operations undertaken by his predecessor.

Experimental operations to ascertain suitable grass-killers may well be undertaken in those Forest Divisions where natural reproduction is so tardy as to border on failure. It should, however, be borne in mind that a species which is suitable in one place may, for climatic or other reasons, not be suitable in another.

"THE TREE OF THE KNOWLEDGE OF GOOD AND EVIL."

BY H. ROBERTSON.

Kurna, a small town, situated at the confluence of the rivers Tigris and Euphrates, about 45 miles from Basrah, is reputed to be the original site of the "Garden of Eden." In this town, at the present day, may be seen a solitary *Albizzia Lebbek* tree, or rather the remains of one. Local tradition has it that this tree is the identical one, the fruit of which Eve is popularly supposed to have tempted Adam to partake of, or, in other words, "The Tree of the Knowledge of Good and Evil."

The stump, as it now stands, is about 10 feet in height with a girth of about 7½ feet, the top part was recently blown off by the wind. Dry rot had apparently set in some time back. Of course there can be absolutely no truth in the tradition, but it would be interesting to know why an Albizzia, in particular, should be given this distinction. The only possible explanation I can offer is that it is probably the oldest tree, as it certainly is the largest to be seen for miles around.

EXTRACTS.

EUCALYPTUS SUITABLE FOR PLANTING IN INDIA.

The following extract from the last Report on the Lawrence Gardens, Lahore will be of interest to those who contemplate planting Eucalyptus in this country :—

Eucalyptus.

"The Eucalyptus experiments which were started five years ago have now gone far enough to show definitely the species which are worth planting in the plains. The following species have been selected from over 100; they are given in order according to their merit :—

1.	Euc. tereticornis		For general planting.
2.	,, rudis	...	For quick growth and saline soils.
3.	,, rostrata	..	Similar to No. 1, but not quite so clean in growth.
4.	,, citriodora	...	Good as a specimen tree, but not for general planting.
5.	,, melanophloia	...	A rough bark tree with very different foliage to most Eucalypti.
6.	,, paniculata	..	A rough barked, fine foliaged tree, of free growth; requires a slightly moister place than Lahore; does well at Amritsar.
7.	,, crebra	...	Very similar to *E. paniculata*.
8.	,, saligna	..	A good variety for moist places
9.	,, melliodora	.	This tree promises well, but cannot be recommended with any confidence, as there are no old trees in the Province.
10.	,, hemiphloia	..	Growth rather poor in the first two years, but soon becomes erect and vigorous.
11.	,, robusta (Swamp mahogany).		Can only be recommended for swampy localities."

DYE FROM CAROB TREE WOOD.

An Argentine joint stock company, with $425,000, authorized capital, has been organized under the name "Compania Argentina de Materias Colorantes," to produce dyes from the wood of the carob tree, treated in accordance with a new process discovered and patented by Dr. J. A. Dominguez, of Buenos Aires. The "Oil, Paint and Drug Reporter" states that the colours produced are khaki and fawn, and other colours obtained by combination. A factory has been erected at Santa Fé, and manufacture is to begin immediately.—[*Oil and Colour Trades Journal.*]

[The Carob tree, *Ceratonia Siliqua*, is indigenous in the countries bordering on the Mediterranean. It has been extensively introduced into India and has become naturalized in the parts of the Punjab and Salt Range. -ED.]

TIMBER-WORKING IN BRITISH INDIA.

The following particulars regarding the employment of timber-working equipment in British India, and the possibilities of increasing the market therefor, are taken from a report to his Government by the Canadian Special Trade Commissioner, Mr. H. R. MacMillan, published in the July 3rd issue of the *Weekly Bulletin* of the Department of Trade and Commerce at Ottawa, and reprinted in the *Board of Trade Journal*:—

Axes, Saws, etc.—The local demands for timber are so great in most parts of India that a large proportion of the wood is cut in the forest by the persons who intend to use it. In such cases, and even where timber is cut on a fairly large scale for shipment to market, only the simplest tools (small locally-made axes with straight handles, adzes and whip-saws) are used. Though contractors and Government Departments have endeavoured to introduce the same type of axe as is used in Canada, together with cross-cut saws, they have failed in most instances to overcome the conservatism of the natives. It has been demonstrated by actual trial, however, that inexperienced natives working with cross-cut saws can accomplish more and better work than

experienced men with axes. Forest officers, in making timber sales, are exercising steady pressure with the object of introducing the type of saws and axes used in Canada, and the market for these articles throughout India may be expected to improve slowly. American logging tools are now generally used in Burma, the most popular type being a 3 lb. axe, which sells, without handle, for 2*s*. 3*d*. retail. All axes used are single-bitt. The cross-cut saws used are chiefly of United Kingdom manufacture.

Saw-mill Equipment.—The saw-mill equipment is almost exclusively British. All the breaking down is done with circular saws set in rack benches. Solid tooth saws are used, 48in. to 72in. in diameter. Frame-saws are used for splitting heavy squares and cutting planks. All other operations are performed on bench saws One mill cutting 18,000 board feet of teak per day had, in addition to four rack bench breaking down saws and four frame gang saws, sixty circular bench saws. Such a mill organization is rendered possible only by the cheap labour, 7½*d*. to 10*d*. per day per man, and the very high profits in teak. As profits from teak decrease, and the proportion of other woods utilized increases, it will be necessary to introduce more efficient machinery.

The imports of saw-mill and wood-working machinery into British India in 1914-15 represented a value of £23,763, of which the United Kingdom contributed £22,492 worth, the United States £459, and Germany £565. Practically the whole of this trade consists of axes, cross-cut, whip, and circular saws, stationary and rack saw benches and simple planers.

Logging Engines.—The manufacture of teak for export is still one of the greatest industries in the whole of Burma. The average annual outturn is about 300,000 tons or 180,000,000 board feet. Teak grows scattered in the forest, and the logs, which average one ton in weight, and reach a maximum of three tons, must be dragged on the average three miles to streams. Up to the present the dragging has been done by elephants, but the large companies operating in teak and the Government of Burma, which works departmentally large areas of teak forest,

are desirous of introducing machinery to supplement or replace the elephant. Nearly all logging in Burma is as yet confined to areas distant from railways The high cost of elephant power is leading timber workers to hope for the development of a portable machine that will travel under its own power thirty to forty miles from the railway.—[*Timber Trades Journal.*]

SAW-DUST FOR EXTINGUISHING SMALL FIRES.

The British Fire Prevention Committee, of 8, Waterloo Place, Pall Mall, London, S. W., have recently carried out a series of tests, the results of which tend to prove that saw dust intimately mixed with bicarbonate of soda and *applied in bulk* has certain advantages over sand and similar materials as an extinguishing medium for comparatively small fires occasioned by the ignition of the vapour of petroleum spirit (petrol) and other inflammable liquids.

When saw-dust is applied to the surface of a liquid it will float for some time, thus excluding the oxygen of the air and smothering the fire. Ordinary saw-dust, as obtained from saw-mills, is the most suitable for this purpose. It must be free from shavings and chips of wood, but it does not require to be either specially dried or to contain added moisture.

The addition of bicarbonate of soda, although not essential, is advantageous. Under the action of the heat from the burning liquid, carbonic acid gas is given off from the bicarbonate of soda adhering to the floating saw-dust, and, accordingly, close to the source of the fire. The gas given off under such circumstances slightly assists in extinguishing the fire Bicarbonate of soda is readily obtainable at a very small cost.

The Committee have found an effective proportion of bicarbonate of soda to saw-dust to be 10 lb. to 1 bushel (or, say, 12 lb.) of saw-dust.

Any form of bin, such as a dust bin or corn-bin, can be used, but a specially suitable bin for the mixture can be made of sheet iron, having a base 24in. square, sides 3ft. 6in. high, top

18in. square, so that the sides slope slightly. The top should be arranged for filling purposes, and at the bottom of one side there should be provided a hinged door 16in. wide and 21in. deep, held up by buttons, the hinges being at the bottom ; on unfastening the door, it should fall on the floor, forming a convenient opening for easily shovelling out the mixture. Such a bin would hold about 8 bushels, and it should be kept in a convenient and easily accessible position, as near the petroleum spirit, etc., as possible.

Any form of shovel or scoop can be used. Preferably it should have a long handle with a large scoop, that suggested having a handle 4ft. long, with a scoop 11in. wide and 15in. long. In order that the shovel should be always handy, it is suggested that suitable provision should be made for holding it on the bin.

The mixture to be thoroughly effective should be applied not only in bulk but rapidly and systematically, the object being to produce what may be termed a lateral "curtain" or scythe effect.

Note as to limitation.—The Committee wish to emphasize the fact that so far their investigations have been limited to small quantities of inflammable liquids not exceeding two gallons, and the areas over which they were spread did not exceed six feet square. These conditions are met with in motor garages and hangars, for which, in the opinion of the Committee, the proposed mixture is applicable and economical.

The Committee take the opportunity of indicating that their tests showed that the application of this mixture or any similar mixture in small quantities from tubes or canisters does not give satisfactory results.—[*Timber Trades Journal.*]

THE FOREST RESOURCES OF NEWFOUNDLAND.

To all who have a live interest in the two disturbing questions—forest denudation and the exigencies of the pulp industry—the Paper by Sir Daniel Morris on the Forest Resources of Newfoundland, read before the Royal Society of Arts, will provide food for much consideration. Why should there be a shortage of either timber or of paper pulp in an Empire with such resources as are possessed by England? The answer is that England has more of Empire than she has been able to assimilate up to the present time. She has neglected her own vast resources and depended on those of other nations, and it is only when some of these have become active enemies and the sources of supply from them have dried up that England has begun to realize dimly that she might have done without them, and it was worth while trying how far she might develop some of her own industrial wealth for her own needs. The case of Newfoundland is a case in point. Here is a colony, one of the oldest of the mother-country, possessing a population all of purely British descent, loyal to the mother-country to the backbone, a colony with a perfect wealth of forest land, and here is the mother-country only a few days' easy sail from the colony, reduced to real straits for two great essentials of her industries—pit props to keep her coal supplies going and paper pulp to keep her literature going—to say nothing of the other uses to which paper of high and low degree is put in these days.

We all associate Newfoundland with fog and gloom, extreme cold and poverty; but what does Sir Daniel tell us? The island is not near as cold as Canada, the thermometer rarely indicates higher than 70° F. or much below zero; it is very picturesque, offers excellent sport, has a healthy climate, is well provided with rivers and lakes and water power, has extensive forests of useful timber, is rich in minerals and has withal over three million acres of good agricultural land. The area of the island exceeds that of Ireland by 11,000 square miles but there are only 243,000 inhabitants to occupy it, an industrious, temperate and well-to-do people who have so far stuck to fishing, mining and forestry and practically

left agriculture severely alone. The cod fisheries of Newfoundland are the largest in the world, and its deposits of hematite iron are the finest to be found in any of the British Dominions with, perhaps, one exception—those at Iron Knob and Iron Monarch in South Australia. There are 10,000 square miles of timbered land on the island, much of it containing an excellent quality of white pine (*Pinus strobus*) which is sawn into lumber and has been used up rather freely, so that it is now becoming expensive. The red pine is suitable for sleepers; the black spruce is used for paper pulp and is reported to be "the best material for pulp-making there is"; the spruce lumber is of exceptional quality, is used locally for general building purposes, for ship and boat-building, and, in the case of the smaller fir and spruce, for pulp. And besides the above, there are various other timbers of less value used both for pulp and other purposes. For the production of lumber there are 12 large saw-mills in operation and there are 120 small mills for minor productions such as cooperage stock, barrels, shingles and laths.

That Newfoundland is an excellent centre for pulp mills may be concluded from the history of the Anglo-Newfoundland Development Company. This enterprise, known shortly as the A.-N. D. Company, spent three years in searching for a suitable centre for pulp manufacture, and after testing the resources of Norway, Sweden, Canada and other countries selected Newfoundland as the most promising, and there secured a forest area of 3,400 square miles in the centre of the island. For power they have the Grand Falls on the Exploits River, and for transport they have the same river down to tide water at Botwood. At the time these mills were completed (1909) they were the largest and most up-to-date in the world; in 1912 they were turning out 200 tons of newspaper per day and in addition 30 tons of ground pulp for export. The capital sunk in the concern is £1,668,653 and the labour force employed in logging operations is 1,500 distributed among 80 camps in the forest. It should here be stated that these mills use balsam fir freely for their pulp, a timber which was at one time considered unsuitable but has come into favour for pulp-

making only in the last ten years. It is said that possibly more than half their pulp is made of this timber though they themselves report it is not near as good as black spruce, and it is difficult to obtain a good finished surface on paper made entirely from it. At these mills both mechanical pulp and sulphite pulp are made and mixed for newspaper manufacture, or are, after mixing, rolled into sheets of pulp, packed in bales and exported. The newspaper is made in sheets of various widths from 112 to 152 inches, and is rolled on reels properly wrapped and protected for shipment to England. At the mills a well-built town has been established containing 2,500 inhabitants; and besides this population a large fishing population does the logging work for the Company during the winter months. Expenditure in wages and salaries alone amounts to £175,000 to £180,000 per annum.

The part Newfoundland is now playing in the supply of pit timber for coal mining is of special interest. It will be remembered that when war broke out Great Britain was plunged in serious anxiety by the stoppage of these supplies which came for the most part from the Baltic Provinces. Her annual consumption was 4½ million tons valued at 5 million pounds. A Commission of Enquiry was then sent to Newfoundland which reported in December 1914 that the colony was capable of supplying to the extent of one-half the quantity that had been received from the Baltic. Arrangements were therefore made immediately and a trade has been established which has already relieved the situation and is likely to continue on a permanent footing.

An important consideration in connection with Newfoundland is that owing to its moist climate reproduction is very rapid and the rotation of forest exploitation is consequently unusually short. There are situations in which it may be put at 15 years in the case of wood-pulp timber; for the whole island an average of from 30 to 50 years may be taken. Nor is there any doubt that were the forests scientifically regulated, as in India, they would be made capable of indefinite reproduction. This is a point now receiving official attention. It reads strangely that the pulp industry of Newfoundland was started by people who

foresaw in 1905 the war that came in 1914, and they are now reaping the reward of their prescience. The island is actually nearer to Britain than the Baltic regions whence supplies used to be received, and so it is unlikely that the Newfoundland trade will ever languish in favour of the Baltic trade. This is only a single instance showing what the mother-country can do to develop her own colonies and make her commerce and her industries self-contained. It required a crisis to show the real worth of Newfoundland; she is open to much further colonization, and when she is properly occupied will become a new sinew to aid the mother-country should war again demand the co-operation of her colonies. We cannot say that this country has been turned to in any notable way in the hour of need, except that her jute productions have been used to a much larger extent than ever. Her manganese and tungsten ores are crying out for further development, and there is reason why she ought not to become the centre of a ship building industry. Let us wait and see what the outcome will be of the labours of the Industrial Commission.—[*Indian Engineering.*]

THE CONIFERS CURSE.

BY R. E. TAFT.

One pleasant day in June, a matter of twenty years ago, a party of sightseers were strolling through a dense forest of spruce and pine in the Rocky Mountains. A young man suddenly stopped, set his foot on a decaying log and delivered a few ill-chosen and evidently hasty remarks.

A "splinter" had penetrated the toe of his shoe and caused some inconvenience to one of his pedal extremities incased therein.

The writer, with an accumulated mountaineering experience of fifteen years, was prepared for such emergencies, and with a small pair of steel pincers soon removed the "splinter," which proved to be a porcupine's quill.

While this "surgical operation" was in progress a little girl with curiosity and sympathy equally divided, came rushing down

the mountain side. An unnoticed bush caught her feet and sent her headlong upon the ground. Scream upon scream of agony rent the atmosphere and the writer's pincers were again called into action to extract two porcupine quills from the palm of one hand and a dozen more from her body and clothing.

Five years previous to this time a hunter had emptied both barrels of a shot gun into a belated porcupine.

As time passed, his adamantine and seemingly imperishable barbs had become scattered over about ten square rods of ground to the inconveniences and results aforesaid.

A few minutes later the party came upon a huge spruce tree with a large section of the trunk near the ground showing clear and white in the rays of sunlight that shot through an open space in the forest.

The porcupine that had chosen the inner bark of the tree for his midday lunch stopped his work to gaze with apparent wonder at the intrusion upon his domain.

A well-directed pistol shot put an end to his depredations.

The death-dealt tree was one of hundreds noted in the course of the day that brought from one of the company the query of, "What is a porcupine good for"? In the good old orthodox days the inquiry would have been dismissed with the simple statement that all things were created for a beneficent purpose; that the purpose became apparent upon close investigation. The close investigations of those days brought the conclusion that the fly was a scavenger that preyed upon and destroyed disease breeding filth—that the mosquito removed bodily impurities that lodged near the human epidermis.

The science of the day has upset and revised those old theories and a war of extermination is now being waged upon those pests.

An acquaintance with and study of the habits of the porcupine, extending over a generation of time, has convinced the writer that this rodent has not one redeeming trait, nor can a good reason be given why he should be permitted to exist. Like his brethren,

the gopher, the rat and the mouse, he should be billed for extermination.

In furtherance of this belief I began a warfare upon the species with gun, pistol and trap and found at the end of a dozen years that no inroads had been made upon the number in my vicinity.

Every day or two I would find a tree girdled near the ground or denuded of bark to the top. In one instance I measured off a block of ground 50 by 100 feet and found forty-two out of fifty-seven trees therein destroyed by porcupines. Their nocturnal habits made it out of the question to rid a neighbourhood of them by shooting, while traps can only be used at the entrance of their dens. There are but two months in the year (May and June) that they are found at large in daylight, and dens are used only while breeding or during cold weather. In summer their nights are spent in foraging and with the approach of daylight they take refuge under a log, rock, clump of sage brush or grass for the day. In the latter retreat they are a constant menace to stock.

A frequent sight in our mountain grazing areas is a cow or steer with nose fairly bristling with quills due to animal having suddenly thrown its head down into a clump of grass or bushes only to land upon the barbed back of a slumbering porcupine.

Nor is this all—the animal is extravagantly fond of salt. Anything containing the slightest taint of salinity is food for his teeth. A prospector's tool handles, ropes, ore buckets, etc., are speedily gnawed to pieces, while the homes of all mountain residents are rarely free from their nightly maraudings from spring till fall. For years the writer obtained some relief from their depredations by the use of a shotgun or six-shooter at all times of night, but the annoying destruction to buggies, sleighs, boxes, barrels, etc., went on, and the work of burning their bodies and clearing the premises of quills was still more exasperating—for when a porcupine is shot or struck with a missile or club the quills fly in all directions—a fact that probably gave rise to the story of

our grandfathers that a porcupine possessed the power to throw his quills at an approaching enemy.

Five years ago the writer moved into a newly completed house, but the quiet of night was soon disturbed by the grind and rasp of a porcupine's teeth. I found that one of them had discovered something saline in the paint on a veranda railing. This gave me an idea and I carried it out in the following manner. A quart bottle was filled with strong brine and a set of boards was thoroughly soaked with it. While still damp, strychnine was liberally sprinkled over them. These boards were distributed in two square miles of forest area and had the effect of completely ridding a half township of the pests.

Some of these poisoned boards were placed in their winter dens; others were nailed to trees above the reach of horses or cattle or under trees whose low-lying limbs prevented stock from getting to them, while others were fenced in. The poisoned faces of those used in small tree areas were protected from rains and wet snow by boards nailed across the tops.

The dead porcupine at the foot of the large tree was the third destroyed during May 1910, at an expense of about one inch eaten from the side of the board. The tree was debarked by the rodents three years previously. It was the only instance where one of them was found near the boards.

Porcupines are very tenacious of life, but it can be taken as a certainty that when their teeth marks are found on the boards, a dead pest will be found in the vicinity.

Complaints of the destructive work of these animals are heard from all sections of our country where conifers grow. I have read of instances where tree owners were paying $1·00 for each porcupine killed on their grounds.

The method I have used will quickly and cheaply put an end to their work, and I would not have given it to the public had I not reached the belief that this most repulsive of all animals should be condemned as a nuisance and its ravages minimized, if he is not entirely exterminated. This can be done by concerted action on the part of private owners, the special agents and

forestry officials in charge of the public domain.—[*American Forestry.*]

[It must be borne in mind that the porcupine of America is a climbing animal and as such has different habits and possibly also different tastes from those of the Indian porcupines.

If porcupines are to be poisoned in India with bits of board previously saturated with a saline solution and painted with strychnine, it would be advisable to insert such boards only in porcupine earths, otherwise various harmless animals, such as deer, etc., which are also fond of salt, would be liable to be victimized.—HON. ED.]

WOOD USED BY SHOE-MAKERS.

The use of wood for shoe-making seems to be increasing, although no records are available to show at just what rate. The wooden heel is at present gaining ground on account of the high-heeled style in women's shoes. More than a dozen factories in Massachusetts manufacture them, and many turn out 500 dozen pairs per day. One firm has made wooden shoe heels continuously for 20 years. Sugar maple, paper birch, and beech are used. Shoe shanks that fit under the arch of the foot are made from wood for many shoes. Veneer of paper birch and sugar maple is used almost exclusively. Shoe pegs and "peg ribbons" are made from paper birch. The "ribbons" are long strips as wide as the peg is long, peeled from the log. They are fed into a machine which splits off a peg and drives it as the shoe passes along through its process of manufacture. Wooden soles are used around furnaces and where workers are on hot floors. Cottonwood, basswood, willow, maple, birch, and beech are all used. There are small factories in the United States that make one-piece, all-wood shoes. Cottonwood is preferred, but basswood maple, and birch are also used.—[*Timber Trades Journal.*]